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Gas Piloting at The World's Fair

Behind the Scenes Description of the Mechanisms Which Make Possible Spectacular Gas Flame and Color Display

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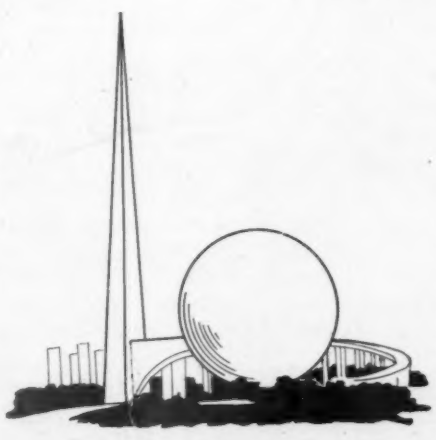
MUCH has been written about the wonders of the New York World's Fair at Flushing Meadows, New York City. Newspapers, magazines, periodicals, (both technical and fictional), as well as prepared papers presented before gatherings and meetings have propounded these wonders at great length. Our gas journals have stressed the importance of gas fuel, the distribution problems arising from its use and the general and varied utilization of gas throughout the Fair.

There is one application of gas about which little has thus far been said,—its utilization for illumination and display purposes. Those of us who have considered this type of illumination as having been completely superseded by the electric lamp, have had a startling reawakening. Mr. Bassett Jones, Electrical Engineering Consultant to the Board of Design of the World's Fair Corporation, who has had the lighting scheme throughout the Fair under his personal supervision, explains that these gas flames give movement and life,—"a quality of aliveness" to the illumination that could not be achieved in any other way. This statement is significant coming as it does from so eminent an authority as Mr. Jones.

All of these gas flames are automatically lighted from various central control points. To plan and carry this out successfully has been an engineering achievement for the Gas Industry of no small magnitude. It is true that we have had automatic gas street lighting for years; but street lighting lamps are enclosed in glass and these elements of nature —rain, snow and wind—are thereby excluded from contact with either the main burners, the lighting pilots or the ignitors.



But, the problem of automatic lighting and pilot maintenance, in the *open*, against the elements of nature, in the many varied required applications of gas for auxiliary or supplemental illumination, or ornamentation of the exterior of many buildings, fountains, ramps and bridges was entirely new. These pilots had to be designed to ignite and remain lighted in hurricane winds, torrential deluges of water, extreme heat radiated from the main burners, dust storms and literally "light under water."

Lest these undertakings be considered exaggerated, let us review some of the conditions imposed upon these gas flame burners and pilots. Let us first look upon one problem confronting the gas engineers with stark reality.

Gas at the Lagoon of Nations

It was proposed to create a mammoth fountain to be called "The Lagoon of Nations,"—a basin some

800 feet long and 400 feet wide — proportions existing heretofore only in the unlimited imagination of the human mind. This fountain was to be different from the stereotyped spectacle of colored waters exhibited in other Fairs. Even the addition of musical accompaniments—heretofore renowned as the "Singing Fountains," or the "Rainbow Fountains," was to be surpassed,—yea, obliviated,—by this new dream of beauty. This fountain must combine all the elements of nature into one massive entity—water, sound, light and *fire*—chaotically blended together — and controlled by the human mind, so as to bring to realism, order, peace and quiet out of chaos. Call it the "Story of the Creation" or reverse the picture, if you will and call it "The End of the World"; at any rate, it must be stupendous, spectacular and breath taking. And so was launched as stupendous an undertaking as yet conceived in the mind of the engineer.

The introduction of fire, or an inferno, into fountain displays was a new and novel idea. Gas was obviously the only fuel which would be safe, easy to control and give flexibility. But to convert this ideaology into a reality would require much research before the tremendous obstacles of lighting these burners, almost under water, would be an accomplishment.

Consider the moment of this one undertaking. About 1400 high pressure water spouts clustered in geometric groups were to belch forth 50 tons of water into the air; these same 50 tons of water would descend unmercifully upon the gas burners below. One might just as well try to ignite and burn gas under Niagara Falls.

Consider other attending problems: — (1) the descending water would flood the burners completely, —(would they ignite?), — obviously a drainage and distribution problem. (2) what action would the descending water have upon the gas flames, —(would they smother?),—a nonquenching problem, also a combustion problem. (3) the action of the cold water upon hot burners, — (would they warp or crack?), — a casting problem. (4) a corollary to this would be the corrosive action of the water upon all metal parts, burners, pilots, etc. (5) what action would such large quantities of water have upon any electric ignition system employed for lighting the pilots, burners, etc., — a difficult ignition problem. (6) to control all gas flames would mean the necessity of installing electric gas valves, such as motor or solenoid valves; — these would have to be waterproof; and the wiring adequately protected against the elements. There were many, many more than we would have space or time to cover.

How all these problems were solved would make a long, although very interesting, story, — a credit to the ingenuity of Mr. Joseph Jares of the Brooklyn Union Gas Company and his associates. The most difficult one, of course, was the igniting problem; it embodied in itself all of the above problems in one.

This development work was entrusted to the Partlow Corporation, manufacturers of Industrial Safety Pilots and Temperature Controls.

From the outset it became apparent that usual methods of ignition would not satisfy all the conditions imposed upon the pilots. After several months of experimentation with pilots of various design, operating against streams of water from garden hose, fire hose, winds from high velocity fans, and sleet created by refrigeration, etc., it was decided that the high tension ignition type of gas pilot would have the best chance of meeting the conditions. Some work had already been done with this type for industrial applications.

As a result of rigid tests, the pilot took definite form in the design of a multi-electrode spark ignitor, operating at 10,000 volts through a special continuous duty transformer. This ignited a raw gas pilot passing through the ignitor of eight electrodes in the form of a squirrel cage and gave positive lighting under all adverse conditions imposed upon it.

The next step was to design a shield or housing for this pilot — to keep it as dry as possible. This took the form of a cast aluminum horizontally split box with a hooded pilot opening at one end and facilities for bolting to the side of the main burners. As additional protection, a sheet metal canopy was later installed above the motor and solenoid valves and transformers to further shed the descending water and to protect the high tension cables from the transformer to the ignitor.

Furthermore, this canopy would protect all of these units against radiated heat emanating from the main burners, to prevent scorching of the electrical units and cables. In short it required the combined and accumulated ingenuity of many minds to perfect this super ignition system.

Today these "water eating" pilots are fondly referred to as "Donald Ducks," each one as plucky a little fellow as his namesake of Walt Disney fame. In reality they are known as No. 247 — just another catalog number, in an unsentimental world of engineering. Yet without the real achievement in designing these unobserved and apparently simple looking pilot devices, the obvious spectacular gas display in this gigantic million dollar "Lagoon of Nations," consuming gas at an estimated rate of 800,000 cu. ft. per hour, would not be a reality or a possibility.

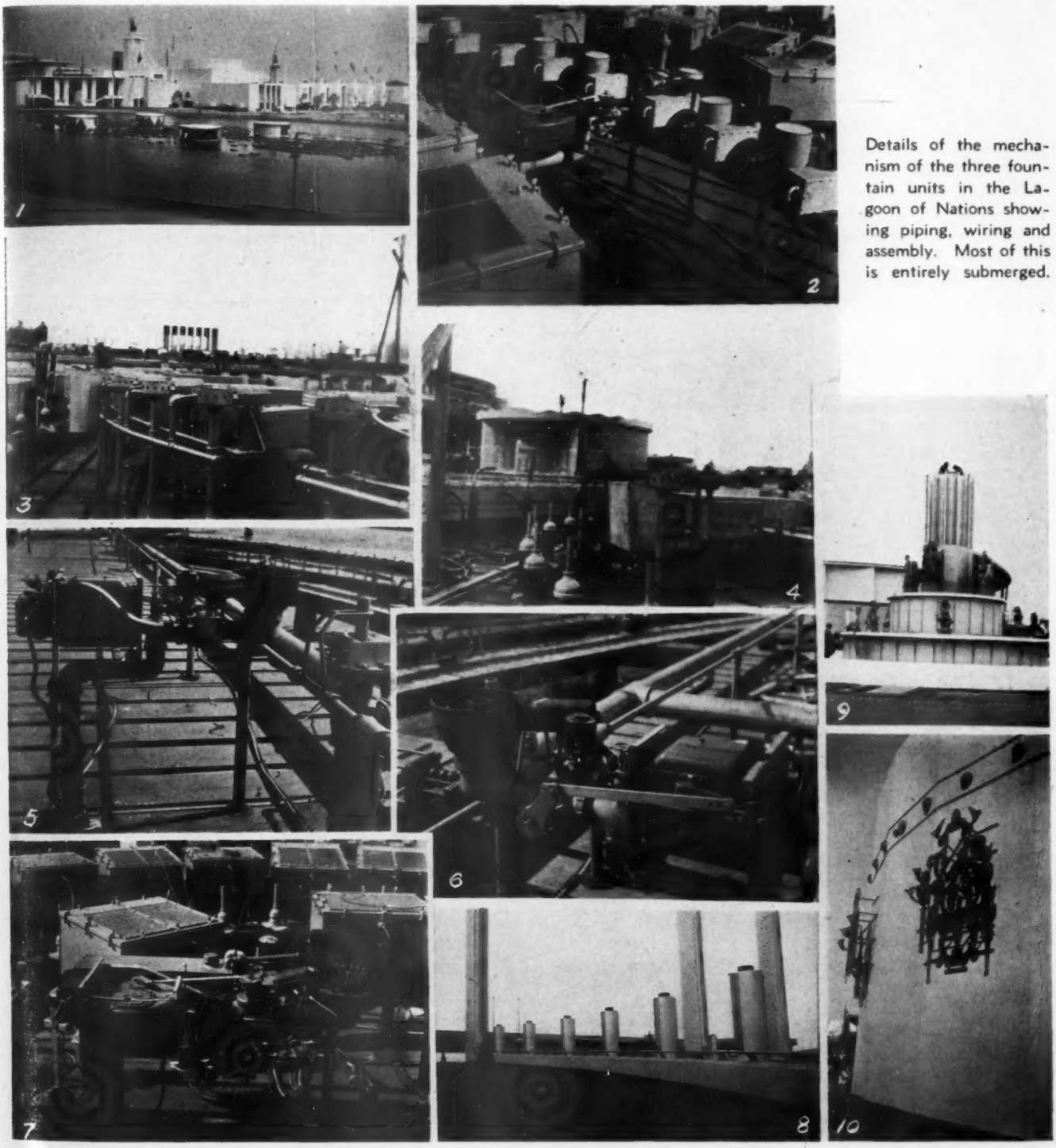
Altogether there are 133 of these vital units hidden away at strategic intervals in the turmoil of the Lagoon, attracting hardly a glance or thought from the millions who witness this nocturnal superspectacle known as the "Lagoon of Nations," at Constitution Mall. They perform their parts without fanfare or trumpeting and with a steady stolidness and confidence.

Pilots for Gas Flares

The pilot problems elsewhere throughout the Fair were less involved, in that nature's requirements were less severe than those imposed by man. Here, only the natural elements, — rain, wind and sleet, presented problems for outside exposed igniting pilots. In those cases, the high tension spark igniters were unnecessary, and less expensive and more compact units could be employed. A second type known as the Heater Pilot was designed to meet these conditions. They consist of a central heater coil of nichrome ribbon, much like the automobile cigar lighter. For economy this ribbon is heated by a small 110 to 2½ volt transformer to a red glow. The heater is enclosed in a special hooded casting to shield it against the elements, and so arranged that the small raw gas pilot flows across the heat zone at gas ignition temperatures. The entire unit is compact and is installed so the gas flame will ignite the main gas burners readily and without hesitation.

At the Gas Exhibit's Building are eight pylons of flame, known as the "Towers of Flame," consuming 18,000 cu. ft. of gas per hour between them. These also were designed by Mr. Jares, after much experimentation. The eight flames are 90 feet high, arranged in pairs, making 4 towers of two columns each, symbolizing the top grid of a gas range. Each pylon consists of 180 jets spaced 6 inches center to center, one above the other. These columns of flame are ignited each by a "Donald Duck" at its base. An interesting effect is obtained by admitting air to

the gas flame at stated intervals through a solenoid valve controlled by an Automatic Temperature Control Program Timer. The effect is that of a running alternation of a luminous and semi-blue flame up the column — a sort of ripple flame, which has attracted wide attention. These pylons surround what is called "The Court of Flame" — the theme center of the Gas Industries Building. In the exact center of this Court, mounted above the high cube of glass is a gigantic torch consuming gas at the rate of 6,000 cu. ft.



Details of the mechanism of the three fountain units in the Lagoon of Nations showing piping, wiring and assembly. Most of this is entirely submerged.

(1) A general view of the "Lagoon of Nations,"—flooded to operating height, showing arrangement of the three separate fountain units,—like a three-ring circus.
(2) Close-up of one battery of six units of the center ring of 72 color flame burners, pilots, color chemical cylinders, rectangular transformer boxes, motor valves and pilot solenoids.
(3) Close-up of battery of color burners showing how pilots are mounted and transformers housed.
(4) Outer ring of yellow flame burners, pilots and water nozzles,—a maze of wiring and piping.
(5) One of 26 individual luminous flame burners distributed throughout the Lagoon.
(6) One of 26 luminous flame burners showing details of piping, wiring and general assembly.
(7) Close-up of the three giant center color flame burners in middle of main fountain. Note compactness of installation. In background are the light drums containing color filters to illuminate the water jets.
(8) A battery of gas candles on IRT-BMT horseshoe ramp.
(9) "Bowling Green Fountain" at IRT ramp. A huge gas flame belches from its top.
(10) The Floral Designs on the Business Administration Building are illuminated by six yellow flame gas burners. There are twelve such plaques or 72 burners in all

A view of the spectacle of water, lights, flame and sound in the Lagoon of Nations at the New York World's Fair 1939. Bathed in ever-changing lights and keyed to a musical accompaniment this fountain display is one of the outstanding attractions of the exposition.

per hour when on full. It is ignited by two heater pilots spaced diametrically opposite one another. The main flame is controlled also by a Timer and solenoid valves, at two minute intervals to produce high and low flames.

Surrounding the Gas Industries Building are 13 high gas torches, of the English flare type, automatically ignited by heater pilots and enveloping the entire building in a rich luminous and golden sheen. Together with the Court of Flames, they make this Gas Industries Building one of the most spectacular and interesting exhibits at the Fair, — a true and great symbol of the Gas Industry, — and a display that will be long remembered in and out of the Industry itself.

Gas Torches

For those who enter the Fair grounds at "Bowling Green" from the I.R.T. or B.M.T. subway, a spectacular gas display presents itself at once. The long horseshoe ramp or approach is lighted on either side by 10 huge gas lighted candles. These 20 torches consuming 4,000 cu. ft. of gas per hour are of the English flare type, and are about 20 feet high. They are also automatically lighted by heater pilots. The long golden gas flames give life and add richness to the visitors' first impression of the Fair. In the center of this horseshoe ramp is a central gas flare, mounted on the top of an enormous and colorful fountain. This torch consumes gas at the rate of about 300 cu. ft. per hour, and is automatically ignited by a "Donald Duck" pilot. This is the terminal of the various sightseeing tours, and the congregation point of delegations to the Fair, — "Bowling Green."

Other avenues of approach have their own spectacular features, — many are gas illuminated. The approaches of the two main bridges, across Grand Central Parkway, Bridges No. 1 and No. 2, the "Bridge of Wheels" and the "Bridge of Wings," are gas lighted by six 38 foot towers, at either end, three to the left and three to the right, and the spans themselves bedecked with colorful flags, banners and plaques. At the top of these towers are huge English Flares, each automatically ignited by heater pilots. These golden flames are visible for miles around. All visitors to the Fair who wish to enter the Transportation Area from the Exhibition Area pass these symbols of the Gas Industry, whether they travel along the Avenue of Wheels or the Avenue of Wings.

Gas Flares

There is another beautiful application of gas for illuminating and decoration purposes at the Business Administration Building, located at the Eastern approach of the Bridge of Wheels (Bridge No. 1). The external walls of this building are decorated with 12 huge bronze floral ornaments. Each plaque is gas illuminated, by six yellow flame burners concealed behind floral designs, but arranged so that the brilliant golden flames rise in liquid and flowing gracefulness, throughout the entire plaque. Thus there are a total of 72 gas burners in this application, automatically ignited by heater pilots. This display is a golden spectacle of illuminosity. It is an indication of what can be accomplished with gas, with application of a little ingenuity.

From all of the above, it will be noted that gas is utilized at the Fair, for a wide variety of services; —most of them are not readily discernible to the Fair patrons as they are inaccessible from view of the general public. The decorative and spectacular display uses, however, are discernible and, therefore, may be observed and studied closely. Most of them are unique and should prove of particular interest, not only to the members of the Gas Industry, but to the general public as well. Few will appreciate the obstacles, which presented themselves to the Gas Engineers assigned to make these displays possible, or the ingenuity displayed in surmounting the obstacles created by engineering imagination, a Utopia in which the engineer was allowed to have full sway in following his vivid hallucinations. Many intricate and, heretofore, unsolved problems naturally resulted. That of mixing Niagara Falls with Vesuvius —the "Lagoon of Nations"—and its attending pilot and gas burning problems, undoubtedly, tops them all.

So, as we watch with awe, this super drama of water, fire, light and sound, let us not forget the unseen mechanisms concealed therein; that without these faithful servants of the gas industry—these "Donald Duck" pilots on guard, — a good part of this spectacular and awe inspiring display would be impossible.

The Value of the Water Heating Load And How It May Be Secured

PART 1

By William H. Howe,

Commercial Manager
The Tucson Gas, Electric Light & Power Co.
Tucson, Arizona

Introduction

APPEARING under the caption of "Seven Lean Years" with a rather startling picture, showing the bleaching skull of some unfortunate range animal casting its eerie shadow upon the barren and parched soil of some remote range region, is the broadside of the joint Water Heating Committee of the A.G.A. and the A.G.A.E.M. Herein is shown a graph, picturing the declining summer domestic load, with manufactured gas showing a decrease of 20.3% and natural gas with a smaller decrease of 8.7% between 1929 and 1937 which is far from being a pleasant thought for those of us in the gas industry. The irony of the situation is further aggravated and more forcibly brought to our immediate attention, however, when we pause to consider that the electric industry has shown a gain of nearly 59% during the identical period of time when we were losing, at least our summer domestic gas load.

The natural reaction is that here is a presentation of cold facts, a rather sad commentary, if you please, and a challenge of "what are we going to do about it?"

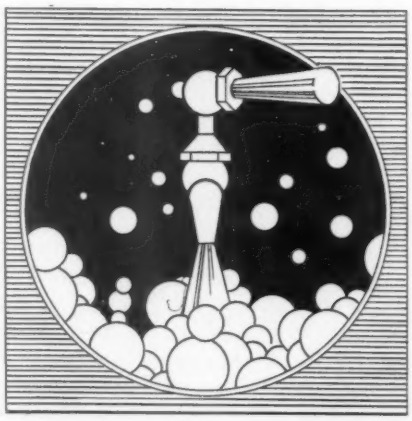
Losing ground in the gas industry, while the electric industry has been making remarkable gains, presents a problem for some serious thought and consideration on the part of the gas industry.

Factors Contributing to Decline

The first thing we will ask ourselves, if we are not afraid to face the cold facts of the matter, is "what have been the contributing factors to this decline in the summer domestic load and what are we going to do about it."

Let us enumerate, briefly, some of the things which may have had some bearing, however remote they may appear upon casual inspection:

1. **Encroachment of the electric industry upon the cooking and water heating load.**
2. **Better and more efficient gas appliances which consume a smaller amount of fuel to do a given job.**
3. **Changed living habits of the American family which mean fewer hours spent in the kitchen.**
4. **Depression years with the resultant uses of bulk fuels for cooking and water heating.**
5. **Competition from oil-fired automatic water heaters with low prices for fuel oil.**
6. **Water coils in furnaces fired with bulk fuels.**



Now let us pause for a moment to consider some of these factors in their various phases and attempt to analyze what effect, or effects, they may have had on the summer domestic gas load.

All of us are aware of the tremendous growth shown in the electric industry and the inroads it has made upon the gas industry with respect to the cooking and water heater loads. Not only has progress been made with the electric range and water heater, but the electric roaster and a myriad of other electric table appliances have done the gas industry no particular benefit. Promotion of the use of electric energy by the federal government through such agencies as T.V.A., Bonneville Dam, and Boulder Dam has reached such proportions in some communities that it is considered a civic and patriotic duty to use electric energy for cooking, water heating, and other household uses. Certainly, these factors have not helped to increase the summer domestic gas load.

Improved and more efficient gas appliances have been the result of constant testing in the laboratories of the A.G.A. Better insulated appliances, notably the gas range, mean less heat dissipation and subsequently a smaller use of gas. Improved top burners with increased overall efficiencies mean a smaller heat loss and, therefore, a smaller use of gas for a given cooking job.

Changed living habits of the American family with fewer hours now being spent in the kitchen is still another factor. The increase shown in the baking industry is mute evidence of the fact that less baking is now being done in the home. The increasing use of frozen deserts, made in automatic refrigerators, is another factor of some importance in this connection.

During the severity of the depression years there were those, who could not or would not pay their gas bills, who began using bulk fuels for their cooking and water heating requirements. In our southwestern community, with the nearby desert areas, is an abundance of mesquite, ironwood, and paloverde trees which make good fuel. When the shadow of unemployment fell upon many people, what did they do but take the family flivver and go to the desert for their fuel.

Competition from oil-fired automatic water heaters is probably not particularly great although those homes already using oil for central heating have been ready outlets for this appliance. Depressed prices for

fuel oil likewise have had some bearing in this respect. Still another item in this connection is the use of the water coil in a central heating system. Admittedly, a water coil in a central heating system is a decidedly wasteful appurtenance but the average man on the street does not know it because he has not been educated to the economy of the gas-fired automatic water heater and the waste of the water-coil gadget. Here is one place we have been lax in our promotion and education of gas for this job.

Now that we have reviewed some of the contributing factors for the decline in the summer domestic gas load, the reaction, logical or otherwise, is likely to be "So What." Most certainly, it is going to avail us nothing to cry over spilled milk and if the gas industry is to survive, each and everyone of us is going to have to do a far more effective selling job than we have in the past.

Doing a better selling job in the gas industry does not indicate, or imply, the use of high pressure promotion; on the contrary, it means doing a selling job with a long term viewpoint and this certainly cannot be done with high-pressure salesmanship. Our job, therefore, is to sell the consumer and keep him sold on the fact that gas does certain things better and more economically than other services.

Ways and Means of Off-Setting Decline

In considering various ways and means of promoting the domestic gas load, we might review the procedure of the electric industry and take a page or two, so to speak, therefrom. It is evident and otherwise apparent the electric industry has accomplished a remarkable job in building their domestic load through the depression years; specifically so, when we consider they have increased the average domestic usage of electric energy about 59% while the gas industry was showing a loss, at least on the summer load.

There are those in the gas industry who feel, rightfully so or otherwise, that the decline in the summer gas load is largely attributable to competition and encroachment of the electric industry. That there has been an encroachment from the electric industry is admitted. There are other factors, however, hereinbefore enumerated and it is our belief that the sum total of these contributing factors is the essence of the situation rather than any individual item.

It is interesting to review recent figures released in connection with the electric industry, indicating the following saturation of major electric appliances.

Refrigerators:	**48%**
Ranges:	**9%**
Water Heaters:	**2%**

From the foregoing it is evident the electric refrigerator has gained the jump on the gas refrigerator. However, the saturation of ranges and water heaters for the industry as a whole has not yet reached alarming proportions, but the electric industry is awake and continuing its promotion. Those of you, who may have seen the portfolio of The Modern Kitchen Bureau, entitled "Guess Again," may herein visualize another headache for the gas industry.

In analyzing the tremendous growth occurring in the electric industry during the past decade, it becomes increasingly apparent that the electric refrigerator has played an important role; probably far more important than most of us are ready to admit upon superficial inspection. Recent statistics indicate there are now more than 11,000,000 electric refrigerators in some 23,000,000 wired homes in the United States or, roughly, 48% saturation. Now, the average electric refrigerator uses approximately 450 KWH per year and with 48% saturation would account for 216 KWH per year of the 294 KWH per year increase shown in the electric industry from an average of 499 KWH per year in 1929 to 793 KWH per year in 1937. From the foregoing, therefore, it is evident the electric refrigerator has accounted for nearly 74% of this increase. Nor is this all of the story. Year after year sees the sales of some 2,000,000 additional electric refrigerators of which probably 10% or 15% are replacements. It is apparent, therefore, the electric refrigerator has been the major item of load building in the electric industry.

It is true that in the gas industry we have the Servel Electrolux which is doing a fine job, particularly on the Pacific Coast, but we must bear in mind the fact the electric industry had the jump on us in this field and it is going to be an uphill pull for the gas refrigerator.

Now the electric refrigerator is one of the most highly desirable loads of the electric industry. Some of the characteristics of this load, making it so desirable, we might enuerate as follows:

1. **A very modest demand averaging about 250 watts.**
2. **Fairly high individual load factor averaging about 20%.**
3. **Extremely high composite load factor considering diversity resulting from high saturation.**

In the gas industry, we have an almost exact parallel or analogy in the form of the automatic water heater which is our intermediate domestic load falling in between the cooking and space heating loads. In our promotional activities and efforts to build volume of load, many of us seem to have lost sight of this intermediate load in the form of water heating. Thousands of dollars have been spent in the promotion of the cooking and space heating loads. Through well organized and integrated programs of promotion the gas industry has built the cooking and space heating loads to the enviable point we see today; but how much thought and consideration have been given to building the intermediate load or, more specifically, the water heating increment? To the extent of aggressive and organized promotion, the water heating load appears to have been a neglected and almost orphaned child. What growth it has shown might be likened to the proverbial Topsy.

Our cooking load is with us the year around and we have taken this item as more or less granted. Recent promotional efforts, as we have viewed them in the form of the C.P. range program, show us the industry has become awakened to the inroads which have been made on this load we formerly thought was invulnerable. The space heating load is a highly competitive field with relatively large volumes of gas being sold at comparatively low figures. The in-between or intermediate gas load is the water heating and refrigeration loads which are with us during the twelve months of the year—day and night—and served with very modest demands upon our distributional facilities. Granting the Electrolux Refrigerator is doing a splendid job in its respective field, the primary consideration before us, therefore, is supplementing this intermediate load. This leads us to consideration of the water heating load, and more specifically the automatic water heating increment. *To accurately determine* what our promotional efforts should be and how much should be expended, we should have some idea of the volume and value of the automatic water heating increment.

Toward the end of analyzing and determining the value of the water heating load, the subsequent studies have been evolved.

Part 2

Volume of the Summer Water Heating Load

During the past, some of us in the gas industry have had rather vague and haphazard ideas of the value of the water heating load. In general, we have thought of an automatic water heater using so many MCF of gas per month at such and such an increment figure. Detailed and reasonably accurate analyses seemingly have been the exception rather than the rule.

At the outset, in attempting to evaluate the water heating load, we find ourselves confronted with several highly variable factors, all of which have an important bearing upon our final analysis and not one of which is likely to be the same in some other locality. The analysis which we are setting forth herein, therefore, covers our own particular conditions as we find them in Tucson, Arizona, a southwestern community of approximately 50,000 population which changed from manufactured oil gas to natural gas in the early part of 1934. As is true with other southwestern communities, having manufactured oil gas, the average annual domestic consumption was considerably below the national average.

Some of the important factors having a pertinent bearing upon the evaluation of the water heating load are set forth hereinbelow as follows:

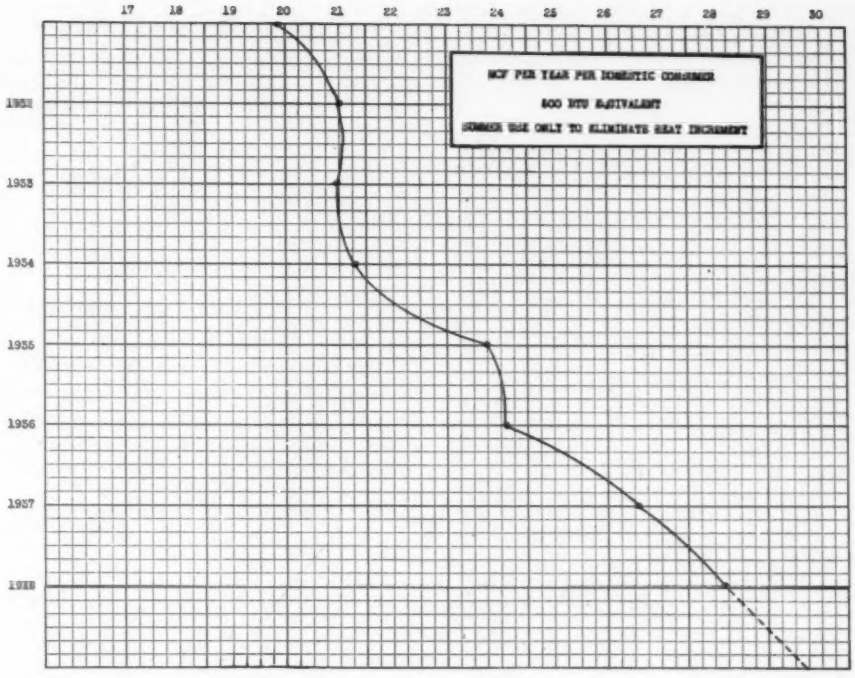
1. **Structure of the generally applicable domestic rate and its relation to the water heating increment.**
2. **Vagaries of the weather or seasonal variations which are directly reflected in our respective degree day deficiencies.**

Upon making a substantial reduction in our general gas rate, effective as of April 1, 1938, which is applicable to all domestic gas service, considerable thought and attention were given to formulating the respective increments of usage and we finally arrived at the following simple block rate:

General Gas Rate

First 10 therms per month
@ 22c per therm
Next 20 therms per month
@ 15c per therm
Over 30 therms per month
@ 6c per therm
Minimum: $1.00 per month

In setting up the foregoing rate, we were proceeding upon the theory, backed by general experience rather than specific working data, that the average home would use 10 therms per month for cooking and incidental water heating and 30 therms per month for cooking and automatic water heating. Just how accurate our estimates in this connection were will be shown in a subsequent issue.



Prior to the change-over to natural gas in the early part of 1934, a detailed survey of our gas system showed we were serving about 800 automatic water heaters, or roughly, a saturation of only 19%. The remainder of our domestic gas consumers were heating water with a tea kettle, a side arm heater, or a combination tank water heater. In the latter part of 1938 another survey shows a saturation of 48% on automatic water heaters, an increase of about 29 points in saturation.

Summer Water Heating Increment

In order to gain some idea of the increment gas load created by an automatic water heater over other forms, we have taken statistics on the summer gas load for the years of 1931 through 1938, inclusive. Domestic gas consumption through the summer months was taken purposely to eliminate the winter heating increment. Since we have knowledge of three factors, (total summer domestic gas sales, number of consumers, and number of automatic water heaters) it is a comparatively simple matter to calculate the increment of gas load created by the automatic water heater over and above other forms of water heating. These calculations are shown in detail on Page 16, herein and indicate an increment of 10.56 therms per month, during the summer, for the average automatic water heater over other forms of water heating. Previous sales figures show beyond any reasonable doubt that the percentage of gas refrigerators, probably does not exceed 1% or 2% saturation and this factor, therefore, becomes negligible in our calculations.

Previous actual experience on the part of this writer showed the summer increment of gas for cooking and a tank water heater to be 4 therms per month. After installing an automatic water heater in the place of the tank water heater, the summer months' gas consumption jumped to 14 therms per month consistently, indicating an increase of 10 therms per month in favor of the automatic water heater. Obviously, this may or may not have been a typical or average installation. However, after reviewing our calculations for all automatic water heaters on our system and considering our personal experience with respect to the summer water heating load, we come to this conclusion:

Specifically for Tucson, Arizona experience indicates, and mathematics verifies, the average summer heating load for cooking and manual water heating to be 6.67 therms per month and for cooking and automatic water heating to be 17.23 therms per month. a difference of 10.56 therms per month in favor of the automatic water.

Just what part the cooking load amounts to we are unable to determine, but we would estimate 3 therms per month.

The Equations

Let X equal gas consumption of consumers with ranges and tank water heaters.

Let Y equal gas consumption of consumers with ranges and automatic water heaters.

(1933) 3,308 × plus 800Y equals 7,170 MCF

(1938) 3,263 × plus 3,012Y equals 14,733 MCF

Solving this pair of simultaneous linear algebraic equations, we find X equal to 1.334 MCF and Y equal to 3.446 MCF or 6.67 and 17.23 therms respectively per month. The difference of these figures, or 10.56 therms per month, represents the average additional usage of an automatic water heater over and above methods of water heating during the summer months.

Tabulation of Summer Domestic Gas Consumption

Year	(x) MCF Domestic	Average Numbers Consumers	(x) MCF Per Consumer Per Year
1931	29,617	4,475	19.85
1932	30,905	4,410	21.02
1933	28,680	4,108	20.94
1934 (y)	31,734	4,474	21.28
1935	37,460	4,739	23.72
1936	40,498	5,042	24.10
1937	48,762	5,496	26.62
1938	58,930	6,275	28.18

(x) 500 BTU per cu. ft. equivalent for 4 summer months of June, July, August, and September, only, to eliminate winter heating increment.
(y) Changed from 500 BTU oil gas to 1,000 BTU natural gas in January, 1934.

Summer Gas Consumption of Automatic Water Heaters vs. Tank Water Heaters

Year	MCF* Per Month	Consumers	Automatic Water Heaters	Percent Saturation
1933	7,170	4,108	800	19.5
1938	14,733	6,275	3,012	48.0
Increase	7,563	2,167	2,212	28.5

*500 BTU equivalent.

Prize Winners of Water Heating Contest

The above committee of judges awarded William H. Howe, of the Tucson Gas Electric Light & Power Co., of Tucson, Arizona, first prize in the nationwide essay contest for utility company employees which was part of a promotion campaign conducted by the Association of Gas Appliance and Equipment Manufacturers for the sale of automatic gas water heaters.

The judges are (seated—from left to right): A. I. Phillips, of the AMERICAN GAS JOURNAL; Floyd Parsons, of GAS AGE; and Stanley Jenks, of GAS. Standing is J. B. Read, of the Columbia Gas & Electric Corp., of New York.

C. C. Griswold, of the Brooklyn Union Gas Co., of Brooklyn, New York, was awarded the second prize of $250.

The third prize of $150 was granted to E. W. Vick, of the New York State Electric & Gas Corp., of Cortland, New York.

W. Daniel Williams, of the Public Service Electric & Gas Corp., of Paterson, New Jersey, was winner of the fourth prize of $100.

Because of the unusual excellence of the many essays submitted, the judges' committee awarded four honorable mentions. These went to: William H. Bispham, of the Rockland Gas Co., of Spring Valley, New York; W. S. Keenan, of the Houston Natural Gas Co., of Houston, Texas; J. F. Kelly, of the Public Service Electric & Gas Corp., of Newark, New Jersey, and E. I. Rudd, Jr., of the Connecticut Power Co., of Stamford, Connecticut.

The subject for this essay contest, which was open to all utility company employees regardless of their respective positions, was "The Value of the Water Heating Load and How It May Be Secured."

Essay Winners in Plumber Dealers Contest

Winners of an essay contest in which plumber dealers in all parts of the country competed for cash awards offered by the Association of Gas Appliance and Equipment Manufacturers as part of their current promotion campaign for the sale of automatic gas water heaters, have been announced from the national headquarters of the Association in New York. The contest was conducted under the direction of the National Automatic Gas Water Heater Sales Committee.

A committee of judges, composed of editors of leading plumbing trade publications, awarded A. S. Betzer, of the Jamieson-McKinney Co., of Ithaca, N. Y., the first prize of $500.

The second prize of $250 was awarded to Kenneth G. Wigle, of the Bruce Wigle Plumbing & Heating Co., of Detroit, Mich.

Edward Zien, of the Zien Plumbing & Heating Co., of Milwaukee, Wis., was granted the third prize of $150.

The fourth prize of $100 was presented to George Stoddard, of Berkeley, Calif.

Honorable mentions were granted to V. J. Killien, of Winnetka, Ill.; G. D. L. Raymond, of Stamford, Conn., and J. N. Roye, of Richmond, Va.

Natural Gas Men Meet at Tulsa, Oklahoma

THE Natural Gas Section of the American Gas Association held its annual meeting in Tulsa, Okla., May 8th to 11th. The program was an excellent one and the attendance is believed to have been larger than that of any previous meeting. (There were over 800 registrations.) All of the sectional meetings were held in the Mayo Hotel, and the general sessions at the Akdar Temple located near the hotel.

The first general session was held Tuesday morning and was presided over by Thos. R. Weymouth, vice-president, Columbia Gas and Electric Company, New York, Chairman. The delegates were welcomed to Tulsa by the Mayor, Dr. T. A. Penney, and, of course, the keys to the city were handed out to everyone.

Mr. Weymouth made an address outlining the activities of the natural gas industry. In one part of his address, he stated:

"There is one aspect of our activity to which I have never heard any one make reference, and yet, to my mind, one may do so with entirely becoming modesty. Every one knows that as a result of the energetic efforts of the gas industry to improve the efficiency of gas consuming appliances, the consumption of gas per customer has been reduced to a marked degree with consequent reduction in gross revenue which passes in large proportion into reduction of net. The point I have in mind is that the industry permits this fact to pass unnoticed by the general public. I think we should make ourselves vocal and claim full credit for our public spirited attitude in pursuing this course. True, some will say that the industry has been driven to this attitude by competition from electricity, but this is only partially true, and particularly is it not true as applied to the natural gas branch of the industry.

E. HOLLEY POE
Secretary Natural Gas Section of A.G.A.

"While I am on this subject I wish to speak of another phase of publicity which I believe is sorely neglected by the natural gas industry, and which, if intelligently and persistently followed, would have a far-reaching effect not only on the public relations of the industry, but also on the possibility of securing satisfactory rates for the service rendered. What I have in mind is our failure to bring to the attention of the public the commodity value of natural gas service, and its ridiculously low cost as measured by what we spend for other things we purchase which are not nearly so necessary to the comfort and necessities of our lives. This can be done by comparing the annual total gas bill for the average family with the bill for rent, or for food, or for clothing or for the movies. The number of sticks of chewing gum equivalent to the cost of gas required to cook a whole meal for the family, or for the number of cocktails equivalent to the gas required to heat the house for a day will give the public a new perspective on the real value of natural gas service to them.

"Another fact which should be brought home to the people when rates are under discussion, is the insignificant effect it would have on the monthly bill of the average customer if a rate reduction were to be made which would be great enough to bankrupt the company. If the public can be educated to facts such as these, I believe the industry would get a better deal when its rates are in question."

CONRAD N. LAUER
President American Gas Association

Conrad N. Lauer, President, The Philadelphia Gas Works Company, Philadelphia, Pa., and also President, American Gas Association, made a splendid address on the subject, "A Mobilized Gas Industry." Mr. Lauer stated:

"Mobilized individual endeavor creates a multiplication of power that results in greater efficiencies, wider scope of usefulness, universally good service and a buoyed morale in the industry. In these times of new ideas and rapid business advancement through organization we are enabled to sense the trends of new methods that we may be prepared to meet 'new ways' and 'new days.'

"Responses to the Bureau's recent inquiry regarding the use of gas for cooking, water heating, refrigeration and home heating in the one and two family dwellings constructed during 1938 are most illuminating. Of 68,000 such new homes constructed in natural gas territory 91% used gas for cooking, 88.9% for water heating, 10% for refrigeration and 77% for home heating. Ten per cent of these homes used gas for all four jobs.

"Of 7,200 homes constructed in mixed gas territory 90% used gas for cooking, 78% for water heating, 23% for refrigeration and 42% for home heating. Thirteen per cent of these homes used gas for all four big jobs.

"Of 27,000 such new homes constructed in manufactured gas territory 82% used gas for cooking, 39% used gas for water heating, 13% used gas for refrigeration and 10% for home heating. Seven per cent of these homes used gas for all four big jobs.

"If the growth and expansion of the gas industry in the last twenty years can be used as a criterion for planning the future we may expect to retain our dominant position in the nation's business picture. The superior service we render is an inexpensive provider of health, happiness, and comfort to our millions of customers and an efficient boon to the technic of industrial planning and manufacturing expansion.

"The future success of the industry lies in our continuing our organized front, not as a line of defense but as an aggressive front line offense. We must continue to blaze the new trails that are open to us and maintain through our Association a mobilized gas industry."

In his address Frank R. Denton, President, Mellon Securities Corporation, Pittsburgh, Pa., stated:

"We may ask ourselves what are the principal reasons for the present high credit position of the natural gas industry and what it is that makes the banker and bond buyer so willing to advance funds to this industry. I believe the answer is that in the first place the banker, the bond buyer and the consumer are thoroughly convinced of the value of natural gas as a fuel. In the second place they are convinced that adequate gas reserves exist and are available to the companies in which they are interested and they realize that long distance transmission of gas from these reserves to the large markets is practical. In the third place the industry has been realistic in its attitude with respect to methods of financing, and finally the industry has had competent management.

The General Session meeting on Wednesday was presided over by Elmer F. Schmidt, Vice-Chairman, Natural Gas Section, and Vice-President, Lone Star Gas Co., Dallas, Texas.

Edward R. Guyer, President, Association of Gas Appliances and Equipment Manufacturers, outlined the activities of that Association in the matter of promoting sales of gas appliances.

Alexander Forward, Managing Director of the A. G. A., talked on the subject, "What We Have in Headquarters," and the wide variety of activities conducted there for the benefit of all phases of the industry.

Louis Ruthenburg, President, Servel, Inc. Evansville, Ind., talked on "Men and Machines." He outlined the research activities of his company in connection with gas refrigeration and illustrated his paper with slides. He stated: ". . . . At the end of 1933, the year in which the air-cooled Servel Electrolux was introduced, there were in the United States 290,117 users of gas refrigerators. Five years later at the end of 1938 this number had increased to 1,052,372. In terms of gas consumption this means an added load of approximately 21 billion feet annually." In speaking of the results of 1938, he said: "As the records were closed at the end of the year three facts of great significance stood forth. The first fact is that electric refrigerating unit volume of 1938 declined 45.9% as compared with that of 1937. The second fact is that the low-priced agencies captured the best share of the market in their history, and the third fact, which to us must be of outstanding significance is that more gas refrigerators were sold in proportion to total refrigeration sales than in any prior year." He also outlined the activities of his company in regard to commercial refrigeration, stating that there are approximately 5,000 commercial establishments where automatic refrigeration is required."

THOMAS R. WEYMOUTH
V.P. Columbia Gas & Electric Co.

Another paper presented at this meeting was "Fair Value and Fair Return" by P. McDonald Biddison, Consulting Engineer, Dallas, Tex. Mr. William A. Dougherty, Counsel, Standard Oil Company, New York, reviewed, "Recent Court Decisions and Commission Rulings and Their Effect on the Natural Gas Industry."

The Industrial Gas Sales Conference held a meeting Monday morning, and another in the afternoon. The morning meeting was presided over by Frank H. Trembly, Jr., Chairman, Industrial Gas Section, and the afternoon meeting was presided over by Franklin T. Rainey, Vice-Chairman, Industrial Gas Section.

Mr. Charles R. Bellamy, Chairman, Industrial and Commercial Air Conditioning Committee, read a paper entitled, "Reaching the Summer Air Conditioning Market Through the 1938-39 Developments in Gas Equipment." After discussing the developments of air conditioning equipment, he stated "the most promising and largest outlet at this time is the commercial field. Less than 25 per cent of the large department stores now have air conditioning and only about 10 per cent of the larger restaurants. There are therefore over 3,000 department stores that are excellent prospects and close to 19,000 restaurants. In addition, there are dozens of shops, theaters, and hotels which sooner or later must install summer air conditioning."

He stated that the second best outlet was probably the industrial field and gave an example of how the St. Louis Match Company increased its production of matches from 24 to 60 million a year through the efficiency added by temperature and humidity control and clean circulated air. This was only one of many.

The paper by D. W. Reeves, Chairman, Gas Engine Power Committee, Industrial Gas Section, outlined the economies and sales possibilities of gas engine loads.

At the luncheon of the Industrial Gas Sales Conference, Walter C. Beckjord, V. P., Columbia Gas and Electric Corporation, New York, outlined how "Management Views the Growing Industrial Gas Load."

At the afternoon session, Charles F. Henness, Public Service Company of Northern Illinois, Chicago, presented a paper entitled, "Approaching Gas Sales from a Salesman's Standpoint Rather Than An Engineer's." The paper was discussed by F. Marion Chelf, Public Service Co. of Colorado, Denver, Colo., and Edwin Snook, Amarillo Gas Company, Amarillo, Tex. It was the consensus of opinion that a good salesman could make a success of selling industrial equipment without being an engineer. The ideal type, of course, is the engineer who

also has a knowledge of the fundamentals of salesmanship. In approaching a problem, the engineer usually starts off with stating facts, whereas the salesman gives the prospect an idea of what he believes gas can do in the way of efficiency and economy in his plant, before getting down to facts. It was conceded that a combination of engineering and salesmanship would undoubtedly produce the best results.

A paper entitled, "Importance of the Industrial Gas Section's Function to the Industry," was presented by Frank H. Trembly, Jr., The Philadelphia Gas Works Co., Philadelphia, Pa. He outlined the many ways the Industrial Section can and does cooperate with the various industrial departments of gas companies.

The Natural Gas Transmission Conference was held Monday afternoon and was presided over by George Young, Vice-Chairman, Transmission Committee, A. G. A. The first paper was by John Clark, Hope Natural Gas Company, Clarksburg, W. Va., entitled, "Dehydration and Resultant Effects on Pipe Line Carrying Capacity and Operation." This paper is included in this issue.

R. G. Strong, Natural Gas Pipe Line Co. of America, Chicago, Ill., presented a paper on "Possible Effect of Lightning on Underground Pipe Lines," and Mr. H. C. Wallace, Chief Engineer, Commonwealth Gas System, Inc., New York, presented a paper entitled, "Small Intermediate Compressor Stations as a Means to Increase Main Line Capacity."

The first meeting of the Domestic Gas Sales Conference was held Monday; F. X. Mettenet, Chairman of the Commercial Section, presided. The first paper "A Show Will Let Them Know," was presented by Harry Swenson, The Peoples Gas Light & Coke Company, Chicago. This paper dealt with the matter of effective display in the sale of appliances. Mr. Swenson feels that the century-old gas industry has not progressed in showmanship as rapidly as it should, but he believes that it is improving rapidly in this respect and gives many suggestions as to how gas companies can make impressive displays and increase sales. He said:

"We have our yearly Auto Show, our national Apple Week, See Your Dentist Week, Call on Your R.C.A. Dealer Week, and a long list of other Weeks both silly and sensible. Why not a gas appliance week, or a month or whatever time is best suited to the locality? We are also in the business, so let's talk about it. All these different weeks have been successful believe it or not, but they've been so because of being a concentrated emphasized activity supported by advertising in every way and made spectacular by every available means." Mr. Swenson further stated, "We all know that in spite of the national advertising and the recent crop of all-gas homes, that hardy perennial the Cooking School, there are thousands who know nothing of modern gas appliances. They have never heard the click of the valve in a really modern range, never peeked into a Servel, and think the minute minder a hero of the American Revolution! They belong to that great army who only believe what they see with their own eyes—they never read an ad through and never go to a cooking school. They have to be convinced by seeing for themselves. For them, a Show Will Let Them Know."

A paper entitled, "Financing the Dealer," by Percy Hall, V. P., Manufacturers Trust Company, New York, pointed out several ways in which the gas companies and the banker can cooperate to cut down expense in connection with the financing of appliances sold on time.

A paper entitled, "The Gas Triangle," was presented by F. M. Houston, Chairman Domestic Range Committee, A. G. A. He outlined the improvements made in gas ranges, and particularly the CP range, and illustrated his talk with drawings and also a short playlet showing how the average housewife attempts to light the oven of her range with a match, with the usual result.

The Wednesday afternoon session of the Domestic Gas Sales Conference was presided over by Davis M. DeBard, Vice-Chairman, Commercial Section, American Gas Association. A paper by W. G. Wiegel, Advertising Manager, Lone Star Gas Co., Dallas, Texas, discussed "Advertising Programs and Dealer Tie-Ins." "Sales Programs Produce Results," was the title of a paper presented by John H. Warden, Sales Manager, Oklahoma Natural Gas Co., Tulsa, Okla. F. X. Mettenet, Vice-President, The Peoples Gas Light & Coke Company, Chicago, Ill., presented a paper entitled, "Market Analysis and Developing Supervisors," in which he stressed the necessity of training supervisors. He illustrated his talk with cartoon sketches of various types of supervisors and pointed out the faults of each. In other words, the supervisor must be trained in all details pertaining to sales in order to be of greatest help to the sales personnel.

There was a Home Service symposium at this meeting; Mr. DeBard turned the meeting over to Miss Mildred R. Clark, Home Service Director, Oklahoma Natural Gas Company, Tulsa, Okla. The home service directors who participated were:

Good will evidently prevails in these groups. Left to right: Merrill Davis, Dresser Manufacturing Co.; C. H. M. Burnham, Panhandle Eastern Pipe Line Co.; G. I. Rhodes, Ford-Bacon & Davis; R. M. Connor, A. G. A. Testing Laboratories; H. C. Cooper, Hope Natural Gas Co.; Thomas R. Weymouth, Columbia Gas & Electric Co.; Harry D. Hancock, Gas Advisers, Inc., Clay Briggs, Cities Service Gas Co.; W. E. Derwent, George D. Roper Corp. and H. D. Grothusen, Gas Advisers, Inc.

Our cameraman caught the above during the Convention. Left to right:—C. W. Sears, Pasadena, Calif.; M. W. Walsh, Louisville Gas Co., Louisville, Ky.: R. H. Hargrove, United Gas Pipe Line Co., Houston; N. C. McGowan, United Gas Pipe Line Co., Shreveport, La.; and J. D. Creveling, Panhandle Eastern Pipe Line Co., Chicago, Ill.

Miss Gladys Price, Chairman, Home Service Committee, A. G. A., Southern California Gas Company, Los Angeles; her subject was "Home Service Answers." Miss Louise Petersen, The Gas Service Company, Hutchinson, Kans., talked on the subject, "The Triad—A Need, A Plan, A Program. Miss Albertine Berry, Lone Star Gas Company, Dallas, Texas, discussed, "The Voice of Advertising." Miss Margaret Thompson, Ark.-La. Gas Co., Little Rock, Ark., discussed the subject "A One-Girl Job." R. S. Agee, Sales Promotion Manager, Association of Gas Appliances and Equipment Manufacturers, New York, closed the session with a paper entitled, "Sell the Seal That Seals the Sale."

The meeting of the Main Technical and Research Committee Wednesday afternoon, presided over by H. C. Cooper, Chairman, consisted of the presentation of various reports.

At the luncheon of the Natural Gas Transmission Conference on Monday a talk was given by R. H. Burdick, Chief Engineer, Southern Natural Gas Co., Birmingham, Ala. His paper will be found elsewhere in this issue. Other papers presented at this conference were given by D. B. Williams, Carbide & Carbon Chemicals Corp., New York, on "The Use of Carbo-Seal Anti Leak." H. N. Fancher, Asst. Chief Engineer, Northern Natural Gas Company, Omaha, Nebr., presented a paper entitled, "Latest Development in Pipe Coating Methods." Aubrey Boyd, Lone Star Gas Co., Cayuga, Tex., presented a paper entitled, "The Foreman's Place in His Community."

The other conferences held during the meeting were the Accounting Section presided over by F. W. Peters, Chairman; the Employee Education Conference presided over by C. L. Hightower, Director of Safety, Houston, Texas; Mr. Hightower also presided at the Accident Prevention Conference.

The genial secretary of the Natural Gas Association of the A. G. A., Mr. E. H. Poe, was probably the busiest man in Tulsa on Monday, Tuesday and Wednesday. I am sure every gas man who attended the meeting, feels the same as your correspondent—that Mr. Poe did a very remarkable job.

On Wednesday noon at the Chairman's Luncheon presided over by Thomas R. Weymouth, two of the original thirteen, who formed the Natural Gas Association in February 20, 1906, were presented for short talks. These gentlemen were Mr. C. W. Sears and Col. M. W. Walsh. A few of the other organizers present were N. M. Sweetman, K. M. Mitchell and J. H. Dunkel.

One of the entertainment features not on the program was a reception given to the Natural Gas Men by the Tulsa Suppliers at the Tulsa Club on Tuesday afternoon, from four to seven P.M. It was one of those affairs where the makings were provided for any kind of sandwich you might want and you could make it yourself. If you wanted a cheese sandwich and desired to sample all of the various kinds of cheese on hand, you would have to build at least a six-decker. There was a variety to suit practically every taste, and the kind of liquid refreshment that each individual desired to help the good work along. Your correspondent felt that the man who originated this idea should be given proper recognition. He found on inquiry that the gentleman was Mr. A. J. Kerr, representative of the Pittsburgh Equitable Meter Company at Tulsa. I am sure if a vote of thanks had been taken to Mr. Kerr it would have been unanimous.

The supply firms participating in this entertainment were:—

American Meter Company, Bethlehem - International Supply Co., Cooper-Bessemer Corp., Clark Bros., Co., Inc., Dayton Coupling Company, Dresser Mfg. Co., Frick-Reid Supply Co., First National Bank of Tulsa, Gaso Pump & Burner Mfg. Co., Hinderliter Tool Co., Ingersoll-Rand Co., Macnick Company, Pittsburgh Equitable Meter Company, Refinery Supply Co., Tulsa Boiler & Machinery Co., Walworth Company, The Webster Engineering Co., Worthington Machinery Corp. of Okla., John Zink Burner Co., National Transit Pump & Machine Co., Fisher Governor Company.

Jenks with Welsbach Street Lighting Co.

According to an announcement by Morse DellPlain, chairman, executive committee, Stanley Jenks, formerly editor of *Gas* and utility sales executive, was appointed, effective May 15, to the staff of Welsbach Street Illuminating Company, Philadelphia, Pa., where he will be located.

The Welsbach Street Illuminating Company owns and operates among others the Kitson Company, manufacturers of gas stops for high and low pressures, meter connections, shut-off and temperature and pressure relief valves.

GET ALL FOUR!

SIMPLICITY—unskilled labor assembles standard parts on plain-end pipe, using only a wrench.

SPEED—typical examples: 5 minutes for 8"; 8 minutes for 14"; 12 minutes for 20" (two workmen).

FLEXIBILITY—expansion and other pipe movements absorbed; curves with straight pipe.

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Another pipe-line builder (22 miles of 10" natural-gas line in central New York State) gets Simplicity, Speed, Flexibility, and Tightness in his pipe joints! His use of Dressers with ALL FOUR gave him faster construction, lowered costs, and completely satisfactory results. ●*Only Dressers Give You ALL FOUR!*

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FITTINGS?—We make a complete line of Long, Cast, Reducing, and Insulating Couplings; also steel and malleable ells, tees, crosses, etc. Write for our General Catalog Number 36.

Again . . .

The Pennsylvania Gas Company selects LCE Worthington Angle Gas Engine Compressors for its new station at Erie, Pa.

Two of three Worthington LCE Angle Gas Engine Compressor units installed in the Erie, Pa., Station of The Pennsylvania Gas Company. Two of the units are used for local distribution of low pressure gas within Erie and the third for booster service between Erie and Warren, Pa. The combined rating of the three units is 525 HP.

IN October 1938 The Pennsylvania Gas Company installed two Worthington LCE units at its Roystone Station for delivering natural gas to Jamestown, New York, and Erie, Pennsylvania.

The thoroughly satisfactory performance of the Roystone installation determined the subsequent selection of additional LCE Worthington units for the Erie Station. The performance of this second installation at Erie has fully justified their selection.

Type LCE Compressors are built in units of 75 to 300 horsepower with single or multi-stage compressor cylinders

• Literature on request

GC9-2

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Some Unusual Problems Encountered in Pipe Line Operation

By
R. H. Burdick
Chief Engineer, Southern Natural Gas Co.

WHEN one is assigned a subject for discussion as broad as that embraced by the caption, "Some Unusual Problems Encountered in Pipe Line Operation," there is presented an opportunity to open a veritable Pandora's box of troubles and woes with which the operation of every natural gas pipe line system is plagued.

In the interests of reasonable brevity and with a view to developing always helpful discussions, I will confine my remarks to two quite divergent topics; one which is applicable to the Southern Natural Gas Company's system and its experiences with its Mississippi River Crossing lines, and the other, the general subject of developing high pipe line system load factors.

Southern Natural Gas Company has no production but purchases all of its requirements from 5 producing companies at a joint receiving station at Perryville, Louisiana, in the Monroe Gas Field.

The Pipe Line System

Its pipe line system comprises 1,288 miles of main and lateral lines ranging from 22-inch down to 3½-inch diameter. The main line is 470 miles long, extending eastward from the Monroe Gas Field to the Mississippi River, across it and the states of Mississippi and Alabama, to Atlanta, Georgia.

This main line consists of 282 miles of 22-inch and 176 miles of 20-inch pipe. 33 miles of 18-inch and 7 miles of 16-inch lines form loops in the initial sections of the main line.

Lateral lines are made up of 206 miles of 12¾-inch pipe, 182 miles of 10¾-inch, 84 miles of 8⅝-inch and 199 miles of 6⅝-inch lines. There are some 119 miles more of 4½-inch and 3½-inch lines in short laterals. The main line is paralleled by the company's telephone system.

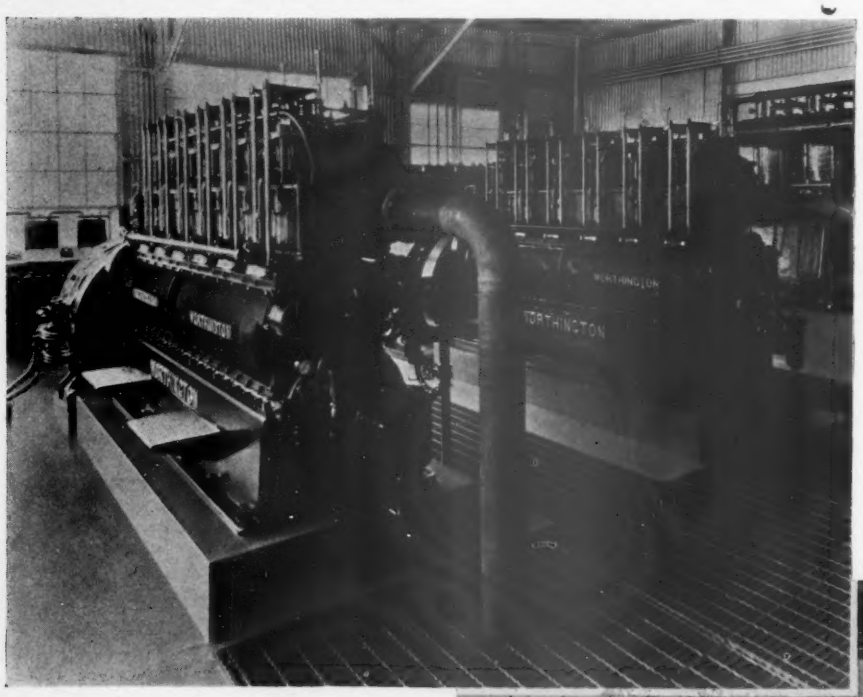
At present the mechanical phase of the system embraces 8 compressor stations with a total of 36,900 H.P. in gas driven compressors.

On the main 22-inch line, stations are located at approximately 60-mile intervals, one adjacent to the Perryville Receiving Station, three in Mississippi and two in Alabama—the last one being situated just north of Birmingham. The maximum discharge pressure regularly carried by these stations is 400 pounds.

Two small branch line stations have recently been erected, one near Selma, Alabama, on the branch line running near Montgomery, Alabama and to Columbus, Georgia (refer to map). This station contains two 400

Read at Transmission Luncheon Conference at A.G.A. Natural Gas Section Convention; Tulsa, Okla., May 8, 1939.

H.P. V-Type engines with angle compressors. The other is situated near Atlanta, Georgia, at the beginning of a branch line serving Macon and Milledgeville, Georgia, and contains one 600 H.P. unit of the new V-Type. These two small stations were built for peak load service and were operated for relatively short periods during the winter just passed.



Above:—Two Worthington 180 h.p. Vertical Gas Engines as installed at stations of Southern Natural Gas Co.

Right:—Four of 7 Worthington 1300 h.p. 24" x 36" Twin Tandem Compressors as installed at Perryville, La.

Territory Covered

The territory through which the Southern Natural Gas Company's lines extend embraces the highly industrialized sections of Alabama and Georgia where large blocks of gas are used daily in the production of steel, steel products, lime, cement, kaolin, ceramics, textiles, steam, pasteurized and condensed milk, electric power, dry ice and numerous other heavy and light commodities.

The delivery capacity of this system, with a load pattern as presently constituted, is approximately 146 million cubic feet per day, exclusive of compressor station fuel gas and line storage depletion. Deliveries are made through 90 metered outlets which include 12 distributing companies serving domestic, commercial and industrial consumers in 52 cities and towns in Mississippi, Alabama and Georgia. The largest distributing company taking gas from this system is the Atlanta Gas Light Company.

River Crossings

From a physical standpoint, probably one of the most interesting features of Southern's system is its Mississippi River crossing. I shall devote some time to a description of this crossing and our experiences with it.

This unpredictable River is crossed by only six of the major natural gas transmission systems. The Southern Natural Gas Company line crosses at a point about 30 miles north of Vicksburg. It is quite probable that other lines will be presently projected across this river and also that some of the existing lines may soon require moving or replacement. Because of these possibilities I trust that our "case history" with the River may be of some aid in simplifying the tasks so involved.

Southern's first crossing was built in 1929 and consisted of 6 lines of 10¾-inch by .483-inch wall, 52.96-pound Class A pipe with screwed joints. The sections were 20 feet in length, coupled with extra heavy collars backed with leak clamps; each joint being reinforced by a 1500-pound bolted cast iron river clamp. These lines were laid in the river channel on 50-foot centers and approached the banks on 20-foot centers. This type of construction was generally accepted as standard at the time this project was instituted.

The river at the point of crossing was 2,900 feet wide between banks with shallow water and a building bank on the Louisiana side and a deep channel and caving bank on the Mississippi or east side. The east bank was graded to give an easy slope to the pipes from the river bottom to the top of the bank and the lines were continued with 10-foot spacing up and over the bank and on to a manifold behind a permanent levee.

Effect of Changes in Water Level

Each year the falling of the river level eroded the east bank somewhat, leaving a perpendicular face with the crossing lines bridging from the top of the bank to the first support in the channel. These lines were thus exposed to the action of river drift and stresses due to vibration caused by the river current. Every Fall this condition was corrected by re-sloping the bank and lowering the lines to a full bearing position.

In September 1935, following a

protracted period of high water, a large section of the east bank caved off on a downstream angle, the movement of earth being of sufficient magnitude to force numbers 2, 3, 4, 5 and 6 lines together in a downstream bend, breaking No. 6 and badly tangling the others. This action occurred approximately 100 feet from shore in 40 feet of water. No. 1, or the downstream line, was not involved.

No. 6 line was identified by divers and was cut under water, raised and relaid 75 feet upstream from its original position. No. 5 line was separated from the others, then raised and moved upstream 50 feet. Lines 2, 3 and 4 were so badly tangled that it was impossible to distinguish one from the other or to change their positions. Inasmuch as these 3 lines were still intact, they were left in status quo as to the underwater portions, but were relaid on the bank with 25-foot spacing, after extensive regrading of their land bearings.

It might be pertinent here to mention that it is practically impossible for divers to operate in a river current in excess of 2½ miles per hour. The current in the channel of the Mississippi River in the vicinity of Southern's pipe line crossing at times attains a surface velocity of 15 miles an hour. We have been very fortunate in securing the occasional services of one of the oldest of Mississippi River divers—a man who is thoroughly at home among messed-up pipe on the bottom of his favorite hunting ground. Incidentally, this man attracted world-wide attention a few years ago when he was caught for over 24 hours in thirty feet of water in the River near New Orleans, equipped with only a diving helmet.

The Mississippi remained reasonably quiescent until February 1937 in which month, as you know, a new high in river grief was established over wide areas.

On the 2nd of that month our No. 3 line broke in 75 feet of water about 300 feet out from where the normal east bank had been. The flood was then causing the channel to shift eastward at an astonishing rate.

Due to the high water—which reached back some 7 or 8 miles, to the Onward, Mississippi, Compressor Station—nothing could be done toward protecting the rest of the crossing lines except to shut off the broken one at the manifold valve tower which was reachable by boat.

Six days later No. 2 line gave way and four days after that No. 4 parted. All of the breaks occurred at the point where the eastern edge of the navigation channel had existed in 1929.

Shifting of Channel

It was the middle of June before the river waters receded sufficiently to allow any active investigation of the crossing conditions. Soundings indicated that the channel had moved eastward over 300 feet and that the west bank had silted-in to an extent of covering lines formerly in the river on that side to a depth of 12 feet or more. Over a period of 8 years, in the vicinity of the crossing, about 500 feet of the western border of the State of Mississippi had moved over to Louisiana.

Although no part of these three broken lines was recoverable for examination, an analysis of the situation indicated that after each succeeding high water period the pipes as they bent upward at the eastern edge of the 1929 channel were robbed of their support by the eastern movement of the channel—accentuated by the caving banks—and had tried unsuccessfully to conform to the new river bed, being bent and rebent in the process, causing so much shortening and suspension that excessive strains were thrown on the joints.

During the 1937 flood, a combination of exceptional current velocity and the attendant efforts at rapid conformation to new bottoms produced greater strains than the joints could withstand.

Relative calm obtained along the river until August 5, 1937, when No. 1 line was found to be leaking so badly about 50 feet from the east shore that it had to be shut off. Two days later, before No. 1 could be repaired, No. 6 parted on the bank—leaving for a short period, only one 10-inch line carrying the system load. Repairs to these last two breaks were consummated within 10 days.

A New Crossing

Because of the instability of the River, its future actions had to be forecast by what it had done in the past and what it might do as a result of channel improvements which had been made and were to be made in the future. After considerable study and consultations with every possible authority on the River and its behavior, it was decided to locate a new crossing about a mile above the original site, at a point where the west bank was under only mild attack and the fickle east bank was protected by a concrete slab revetment. At this point the river is normally about 4,000 feet wide and is relatively shallow. The shallow channel at this point has some advantages over the deep channel at the lower crossing but it also has certain disadvantages as will be shown later.

Once a site was decided upon, the work of making detailed soundings and survey, design and accumulation of materials and equipment and also of clearing new rights of way in the Louisiana jungle bordering the river, proceeded rapidly.

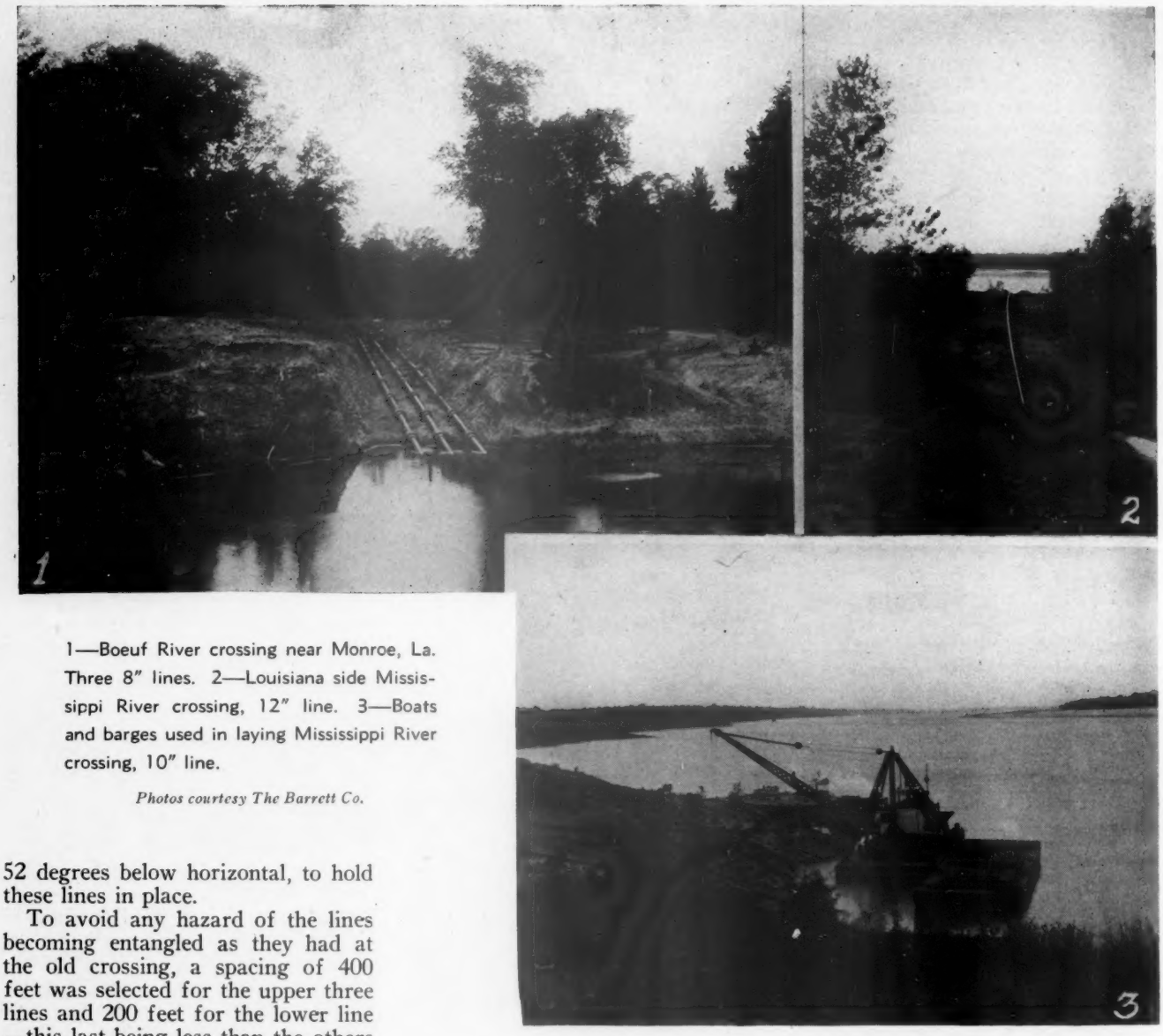
The new crossing design prescribed four 10¾-inch by ½-inch wall, 54,735-pound Class B seamless lines to be laid in an upstream arc, electric welded and equipped with 1500-pound river clamps every 40 feet on 3 of the new lines instead of the 20-foot clamp spacing formerly used.

The chief incentives to keep the river clamp spacing as wide as possible or eliminate them entirely were the reduction of weight and consequent lowering of vibratory stresses should portions of the lines become suspended in the water.

River Clamps

It was decided that as these clamps performed no useful work as joint stiffeners on welded lines, they could be placed in any positions where accurate 40-foot spacing might dictate. As a concession to scientific experiment—after a series of rather involved calculations of the resultant forces of pipe weights, river current, up-drafts and buoyancy—it was decided that the fourth new line would be laid without clamps. In this connection, it was determined that vibration due to river currents could cause a fiber stress of 34,155 pounds per square inch in lines weighted as the other 3 lines were to be, but only 19,536 pounds in an unweighted line. Inasmuch as there is little danger of a suspended line breaking from fiber stresses when they are less than 50% of the tensile strength, the elimination of weights seemed very desirable.

Our calculations showed that with a negative buoyancy of 15.43 pounds per foot of pipe length and a river bottom current of 6 miles per hour (which was to be expected shortly after these lines were laid) there would be a force of 51.5 pounds per lineal foot to drive the pipes into the silt and mud of the river bottom at an angle of 36 degrees below horizontal. During low water periods a bottom current of 3 miles per hour was expected to provide a force of not less than 20 pounds per lineal foot of pipe operating at an angle of



1—Boeuf River crossing near Monroe, La. Three 8″ lines. 2—Louisiana side Mississippi River crossing, 12″ line. 3—Boats and barges used in laying Mississippi River crossing, 10″ line.

Photos courtesy The Barrett Co.

52 degrees below horizontal, to hold these lines in place.

To avoid any hazard of the lines becoming entangled as they had at the old crossing, a spacing of 400 feet was selected for the upper three lines and 200 feet for the lower line —this last being less than the others in order to avoid an accentuated reverse curve as this line approached the east bank.

Method of Laying Line

With all preparations carefully made, a river fleet of tugs and barges with their attendant crews and auxiliary equipment arrived on the scene on September 17th, active construction being started the next day. Sixteen days later the four lines were completed in the river, ready to be connected to the land lines and new main line manifolds.

The attempt to lay the one line without weighting it with clamps demonstrated very promptly that the stiffness of Class B, ½-inch wall pipe, was such that even filled with water and having the negative buoyancy and the downward pressures referred to, it would not conform to the irregularities of the river bottom and that the probabilities were that when cleared of water it would bridge between high points on the bottom without embedding itself as would the weighted lines. Because of the danger from vibratory stresses with a line so suspended in the river current, and also because it might present a low water navigation hazard, this experiment was abandoned and the line was weighted after the manner of the other three.

These 4 new lines were laid in conformance with the time-honored theory that an up-stream arc was necessary to keep them in compression and to provide slack. In spite of this concession to precedent, there is a question in our minds as to its application in this particular case, because the channel of the Mississippi continually shifts from place to place, and practically every section of lines in this river is either gripped firmly by the silt covering it or is in tension between such holding points.

The old crossing was revamped as to the 3 remaining lines, all joints being welded from headers to the water's edge. The pipes in the water were dredged down to a firm, even bearing on the bottom to reduce strains on the screwed joints to a minimum. Another innovation in the river crossing construction was instituted by incorporating a fourth line in the old crossing, laid out from the west bank at a right angle to the river as far as the western edge of the then deep channel and thence across the channel in a parabolic arc with the middle ordinate of approximately 700 feet, the apex of which was downstream and at the eastern edge of the channel and the foot of the east bank. In this location the pipe approached the east bank parallel to the direction of earth movement and it is believed it will be less affected by earth slides and cave-ins than would a line approaching the bank with an upstream angle and

crossing the direction of earth movement. Very shortly more news of this particular piece of construction will be available, for the high water for this year will begin to recede late this month. This year the River has taken with it over 150 feet more of that particular section of the State of Mississippi.

Leak Tests and Causes

Pressure tests on the new crossing lines in November of 1937 disclosed that No. 2 line had developed a serious leak about 700 feet out from the east bank; a faulty weld was suspected. As soon as a river fleet could be assembled this line was raised progressively from the east shore, cut into 80-foot lengths, the leak-section eliminated and then relaid back to the bank again. Examination of the leaking section of the line disclosed several lateral gash-like dents at regular intervals for a distance of about 15 feet, one cut being deep enough to penetrate the ½-inch wall. These gashes were identified as having probably been made by a large boat propeller which had apparently fouled the pipe in the process of pushing a string of freight barges around the bend at this new crossing during some low water period.

In January 1938 the new No. 3 line gave evidence of complete severance in the general location of the earlier leak in its companion line. In all probability, the same enthusiastic propeller had attacked this line, although this point has never been confirmed. In the fall of 1938 repairs were made by lifting the outer section of this No. 3 line and welding new pipe onto it, which was then continued on to the east bank and connected to the undamaged land line. The eastern section of this line was abandoned to the river, being embedded in the channel to a depth which precluded its recovery.

Pipe Standards

We have concluded from our experiences, and also from further studies that future river lines if built with 10¾-inch pipe, should be made of Class A steel, with a wall thickness of ¾ of an inch (weighing approximately 80 pounds per foot) and possibly laid with little or no upstream arc. This design we believe would give ample weight to keep the pipe embedded and this weight would be in useful metal rather than in dead weight clamps. The even distribution of weight thus obtained and the relative ductility of Class A pipe would eliminate certain objectionable beam stresses and other stresses such as are imposed on the more rigid Class B pipe carrying concentrated loads in the form of 1500-pound clamps every 40 feet.

Presently the lines comprising our two crossings have functioned for 17 months without trouble except for that caused by the rampant tug boat and, while they have not been subjected to any unusual flood conditions during that time, we are hopeful that the problems in connection with them have been solved, but right here I want to pay my honest respects to the old Mississippi River by saying that all of us who are concerned with the health and welfare of these crossing lines are keeping our fingers crossed.

Load Factor

The value of a good annual load factor and particularly its companion factors—the ratios of average and maximum days' demands to delivery capacity—in the economic scheme of a natural gas pipe line system, needs little or no emphasis. The ratio of maximum demand to delivery capacity—which for convenience I shall designate as a "capacity factor"—takes on particular significance when it reaches 100% and thus indicates that costly increases in compressor station additions and/or the even more costly line looping will soon be required.

Continued increases in maximum demand can readily lead to very considerable outlays for additional transmission capacity, all of which, in the ordinary course of growth of our business, would not be immediately usable. It is at this point that the economics of "peak shaving" indicate a possible means of sustaining a good "capacity factor." Peak shaving, as an economic device, is sound as long as the net revenue concessions for quantities of gas sold on a "when available" basis (as compared with probable "firm" gas rates) plus any loss in net revenue from the gas not delivered during periods of interruption plus any added expense involved in securing cut-off privileges, add up to less than the capital charges involved in providing full peak capacity minus the net revenue which would accrue from delivering this gas at firm rates. The term, "net revenue" used here is intended to represent the revenue derived from the gas sales minus all parallel operating expenses.

To keep a system's "capacity factor" close to 100% is desirable but requires fairly accurate forecasting of probable increases in maximum demands and the corresponding "peak shaving" needed to approximate this 100%.

Besides the usual calculations of increases in domestic requirements, based on the number of new consumers connected by distributing companies served by the system, the degree-day-deficiency method and the like, and the inclusion of definitely calculable increases in commercial and industrial loads which may be expected, it is well to give consideration to the total of the all-time peaks of every delivery point, which a proper combination of weather and business activities might make coincident. Consideration should also be given to the system's "diversity factor" as a modifying element to the possible co-incident peak.

Usually the first plan to be considered for improving a system's load factor is the institution of "interruptible" arrangements with large industrial consumers. Among the devices which we have considered in order to provide interruptible privileges are:—

1. The provision of fuel oil to be used by those who have oil burners as stand-by equipment for certain types of furnaces — particularly boilers.

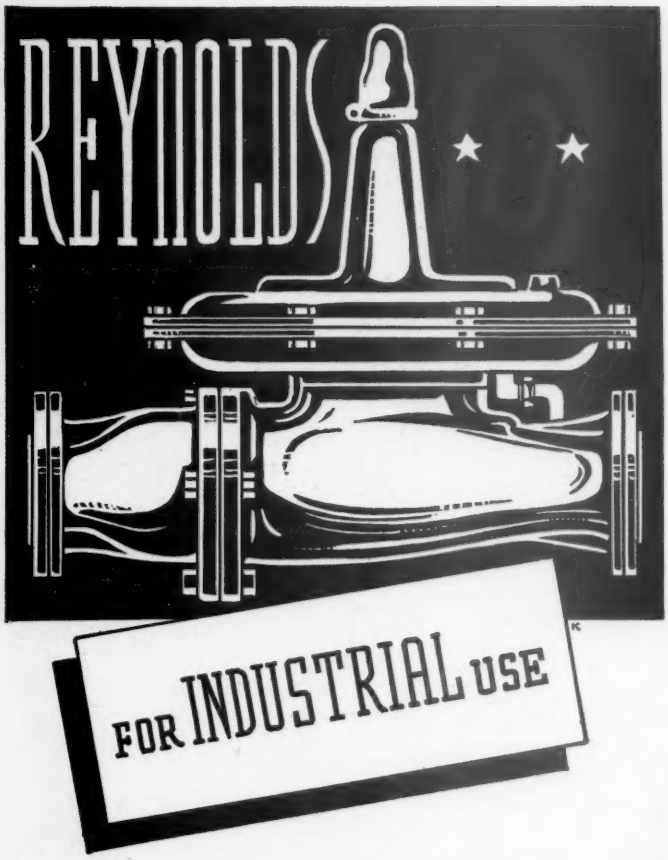
2. The furnishing to at least one town plant, sufficient gas oil to permit operation of its gas plant for several days to produce a portion of its gas requirements in the form of high thermal value manufactured gas. This to be supplemented by an arrangement for us to bear the actual expense of manufacturing such gas less the cost of oil and the equivalent amount of natural gas at the prevailing city gate rate.

3. The supplying of sufficient natural gas (as soon as possible after periods of interruption and without cost to the consumer) to certain types of heating operations, to return those operations to the heat or temperatures they were at, at the time of interruptions. This refers chiefly to the ceramic industries with some of which, arrangements can be made to supply, at our expense, enough gas to return their kilns to the temperature conditions which may be registered at the time the gas supply is cut off.

Delivery Capacity Increase

Like all other transmission system operators, we have sought the best means of attaining as closely as possible, 100% load and capacity factors. There is, however, a limit to

(Continued on page 58)



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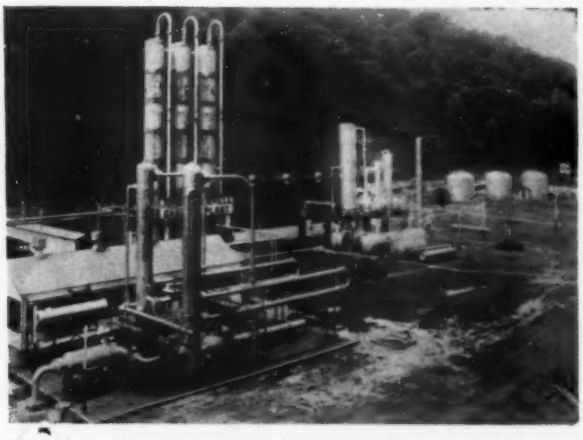
Dehydration and Resultant Effects on Pipe Line Carrying Capacity and Operation*



The Hope Natural Gas Co.'s 1000 pound Dehydration Plant at Clarksburg, West Virginia.

By John Clark

Hope Natural Gas Company
Clarksburg, West Virginia

DURING the years when the depression had almost stopped production, all the major companies in every industry had concentrated on research and development to improve and cheapen their product. This was particularly true of the steel industry, and marked improvements were made in the production of pipe having higher tensile strength, and at a cost that would allow it to be used in competition with the lap-weld that was the usual practice. For some time our engineers had been considering methods of using these new products economically, and had worked out a design using much higher pressures and stresses than usual.

After the severe winter of 1936, our company felt that additional line capacity was required from a newly developed field in southern West Virginia to our central plant about 95 miles north at Hastings, and from there 100 miles north to a point in the Ohio delivery system. Our first thought was a twenty inch line, operating at 350 pounds to 400 pounds, discharging into a 100 pound suction line at Hastings, and then being repumped for delivery into Ohio. However, this seemed to be a logical place to try out the idea of high pressure, and the saving in first cost justified us in going ahead and adopting this idea.

The final decision was to lay the first 95 miles, and discharge ahead of Hastings at 325 pounds gauge with 1000 pound compressors at the south end, and later lay the remaining 105 miles, and install another stage of compression to raise the pressure to 1300 pounds gauge. The pipe selected was twelve inch inside diameter seamless steel pipe, Grade B with .32% carbon, and an ultimate strength of 65,000 pounds. With this pipe we felt safe in using a safety factor of three, and this gave us a safe working pressure slightly over 1300 pounds. The question of joints was the next serious problem, and it was finally decided that a solid welded line was the only safe solution, and expansion would have to be taken care of by the frequent bends required by the rough terrain. Later on, during construction, it was found we average 63 bends per mile, and there have been no expansion troubles to date, which justified this decision.

The next problem encountered was that in this country we had frequent records of gas temperatures as low as 30°, and at the proposed pressures, freezing would be a serious problem, and dehydration down to a dew point of 20°, at least, seemed required. In 1936, the formation of hydrates had just begun to be studied, and there were very few plants built at that time. Also, this plant had to be very flexible, as at first it would have to dry gas at 1000 pounds and 62° down to a 20° dew point, but after the last stage of compression was added on the outlet side of the dehydration plant, it would have to dry gas to a 20° dew point at 1300 pounds, which is equivalent to a dew point of 8° at 1000 pounds. So the final choice was a plant circulating, through contact towers, a concentrated solution of calcium chloride in water, which by its hygroscopic action gave a 20° depression of the dew point, and then by refrigeration this solution was chilled to 30°, giving a gas temperature of 40°, and a dew point of 20°. By suitable heat exchangers between the incoming and outgoing gas, this cold was recovered, and the refrigeration cut to ⅓ that required without heat exchange. For refrigeration both ammonia, propane and butane were studied, but ammonia was finally selected because of its lower operating cost. This plant has been operating now for three years with no trouble at all but minor mechanical difficulties, and last winter its average operating cost, without interest or depreciation, was 1.16 mills per M.C.F. when treating an average of 45 million cubic feet per day.

To show its flexibility, we operated the first two winters with an oil absorption gasoline plant on the suction side of the compressors to remove the gasoline. In 1938, the feasibility of shutting the absorption plant down was studied, and, as a result, another 40 ton ammonia machine was added to the plant. With this, brine temperatures were reduced to 0° F, and the gas chilled to 10°, resulting in the removal of as high as 3500 gallons of gasoline per day, and allowing the entire savings of the cost of operating the absorption plant, with the only added cost, that of running one 60 horsepower engine.

Since this plant was built, other methods have been developed, and there seems to be a particular field

* Paper presented at Natural Gas Section, A. G. A., at Tulsa, Okla., May 8-11, 1939.

for each design. The first improvement was the adding to the calcium chloride solution of about 20% glycerine, which increased the dew point depression to about 30°, and in most cases obviated the necessity of refrigeration. The most radical change was the substitution for the calcium chloride solution of a mixture of di-ethylene-glycol and water, which by its very low vapor tension, produced a dew point depression of about 40°, and in any normal case eliminated all necessity for chilling. Later it was found practical where the gas was sour to add to the solution other chemicals which would absorb the hydrogen-sulphide, and thus, in one plant, remove both sulphur and water.

As the situation now stands, where a gasoline plant is already in operation or sulphur removal is a problem, the glycol or glycerine plant will likely work out the cheapest in both first and operating costs. However, where a new installation is contemplated, the flexibility of the calcium chloride plant with refrigeration, and the practicability of combining dehydration and gasoline removal in one plant, gives this design advantages worthy of serious consideration.

After three years operation, this plant and line as described have been so satisfactory that we consider it a successful installation. Half time of one man has been sufficient to control operation, which is nearly automatic, watching temperatures being the main task. At first we had some trouble with carry over, but this has been overcome by an outlet drip tank and mist extractor. Once a day we check the dew point for both water and hydrocarbons with the machine developed by Mr. Deaton of the Bureau of Mines, and have found a dew point of 30° F. satisfactory and most economical. We have found it possible to nearly eliminate line walking due to the remarkable tightness of the line, as after five months shut in, the loss of pressure could not be read on the gauges. The line has gone through several severe floods with no river crossing trouble, and, as a result, we are laying a crossing of the Ohio River this summer, with single twelve inch welded line, the same as the crossings on the smaller streams.

Due to its tightness and absence of any water, this has made a very excellent test line, and we have been able to duplicate tests made a year apart to a fraction of one percent. Soon after the line was put in service, we ran a very complete series of tests of carrying capacity, which tests have been checked several times since. From these tests we have found that, due to the super-compressibility of the gas at these high pressures, we were getting flows much in excess of those expected from the Weymouth formula, approved by the A.G.A. We obtained a super-compressibility testing machine, and from its results, drew curves showing a super-compressibility through the entire range of pressure of various gases, both wet and dry, as well as of pure methane and ethane, at usual temperatures and up to 2000 pounds pressure. From this data, we have found that within about 2%, the flows obtained were equal to those given by the Weymouth formula, multiplied by the super-compressibility of the gas used, at the average pressure on the line. This average pressure is given by the formula:

Gas Flow Formula,—(See third column)

$$Q = Cd^{8/3}\left[\frac{a(P_1^2 - P_2^2) + 4/3b\ (P_1^3 - P_2^3) + 3/2c(P_1^4 - P_2^4)}{L}\right]^{1/2}$$

$$P_{average} = \frac{2/3\ (P_1 + P_2 - P_1 P_2)}{P_1 + P_2}$$

As an example, using an average dry gas with an average pressure of 300 pounds the increased flow was 6%, at 500 pounds it was 11%, at 800 pounds it was 18% and at 1000 pounds it was 24%. Above this pressure our present equipment does not allow us to make any tests.

This equation gives sufficiently accurate results for ordinary designing and checking, but for a final check Mr. C. C. Reed of our company has developed, from the basic gas laws, a formula which seems to check the test results almost exactly.

This formula is as above:

All of these quantities are the same as given for the Weymouth formula in Monograph No. 6 of the Bureau of Mines, except the constants a, b and c. These are obtained by substituting values from the super-compressibility-pressure curve of the gas used, in the formula: $K = a + bP + cP^2$, where K is the super-compressibility as determined by test, in the gas state formula $PVK = RT$. In this, a is, for all practical purposes, unity.

In conclusion, after three years experience with this type of design, we feel that the most economical line, especially for long distances, is the one using quite high pressures, well above 1000 pounds, to stress the steel to its maximum safe limit, and get the maximum advantage of super-compressibility, and dehydrated to five degrees below the lowest temperatures expected in operation, so that the carrying capacity will be maintained continuously at its original efficiency.

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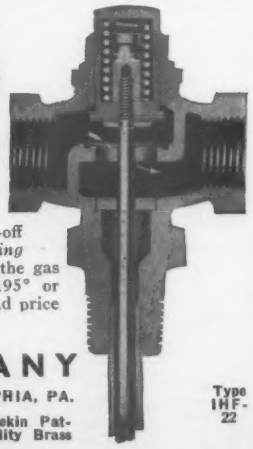

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Use of Carboseal Anti-Leak

by
D. B. Williams
Carbide and Carbon Chemicals Corporation
New York, N. Y.

I HAVE been asked to speak about a technical development—Carboseal* anti-leak—a product now widely sold for correcting leakage in bell and spigot joints in cast iron systems distributing dry gas. Over 250 gas properties in the United States are succesfully using this product. A large percentage of these distribute natural gas which is essentially dry.

Gases inherently dry are:

(a) Natural gas.
(b) Hydrocarbon gases such as propane and butane with or without air carburetion.
(c) Manufactured gas passed through transmission lines at high or intermediate pressure and distributed at low pressure through district governors in the same system.
(d) Manufactured gas which has been compressed for transmission at high pressures to neighboring communities for low pressure distribution.
(e) Mixed manufactured and natural gas.

The problem presented by increased joint leakage attendant upon the substitution of dry gas for wet was recognized many years ago and various means were adopted for correcting this condition:

(a) A method reported to be entirely satisfactory by many companies consists of applying a leak clamp at each joint after properly preparing the face of the bell to receive the clamp. This, of course, involves expensive excavation and repaving costs in addition to the cost of the clamp itself. The necessity of securing permits from the city and obstruction to traffic must also be considered when this method is used.

(b) Rehydration. Dry gases stored in water-sealed holders pick up some water and the send-out may be partially saturated particularly in the summer months. Any benefit secured from this water vapor is probably restricted to mains within a very limited radius.

(c) Oil fogging. Oil fogging has been adopted alone or in conjunction with rehydration in many systems. The principal claims for oil fogging are that it postpones drying out of the packing in bell and spigot joints following a change-over, prevents the formation of, and lays, dust in the system, and postpones drying out of leather meter diaphragms where the original dressing oils have been leached out by condensable hydrocarbons present in "wet" gas formerly distributed. Oil has only a slight swelling action on the jute or hemp packing in the joints[1, 2, 3] and it is doubtful if oil has any beneficial effect from the standpoint of correcting leakage once it has developed following a change-over, although in portions of the system where oil and water vapor artificially added are present in sufficient volume, they undoubtedly slow up drying out of the joints.

Development

Early in 1931, Mr. G. E. Hitz of the Central Hudson Gas and Electric Corporation, Poughkeepsie, N. Y., in seeking an improved method of solving the problem, studied the application of liquids directly to the mains to correct bell-and-spigot joint leakage. Oil pumped from the drips in portions of the system distributing wet gas was mixed with gas oil and applied by gravity at high points in sections distributing dry gas. The liquid in running over the bottom of the joints was picked up by capillary action, resaturated the packing and reduced the leakage. It was found, however, that while this served to alleviate the leakage condition for from one to three months, the leakage returned after that time due to evaporation of the oil into the gas.

Mr. Hitz recognizing the temporary nature of the oil-treating processes turned his attention to the application to the interior of the main of other types of liquids. Co-operative work along these lines was carried out early in 1933 between the Carbide and Carbon Chemicals Corporation and Central Hudson Gas and Electric Corporation, and later more extensive investigations were carried out in the laboratory of The United Gas Improvement Company in Philadelphia. As a result of these investigations it was found that certain high-boiling liquids which would swell the jute or hemp packing in the joint in a manner similar to that of water would maintain a leak-tight condition permanently.

During the laboratory investigation a search was made of all materials or compounds which appeared in any way suitable for the purpose. The following is a broad classification of chemical types included in the laboratory phases of the investigation: water, aliphatic acids, mono- and polyhydric alcohols, aromatic alcohols, alcohol-ethers, aliphatic and aromatic aldehydes, aliphatic and aromatic amines, aliphatic and aromatic esters, hydrocarbons and various mixtures of these types.

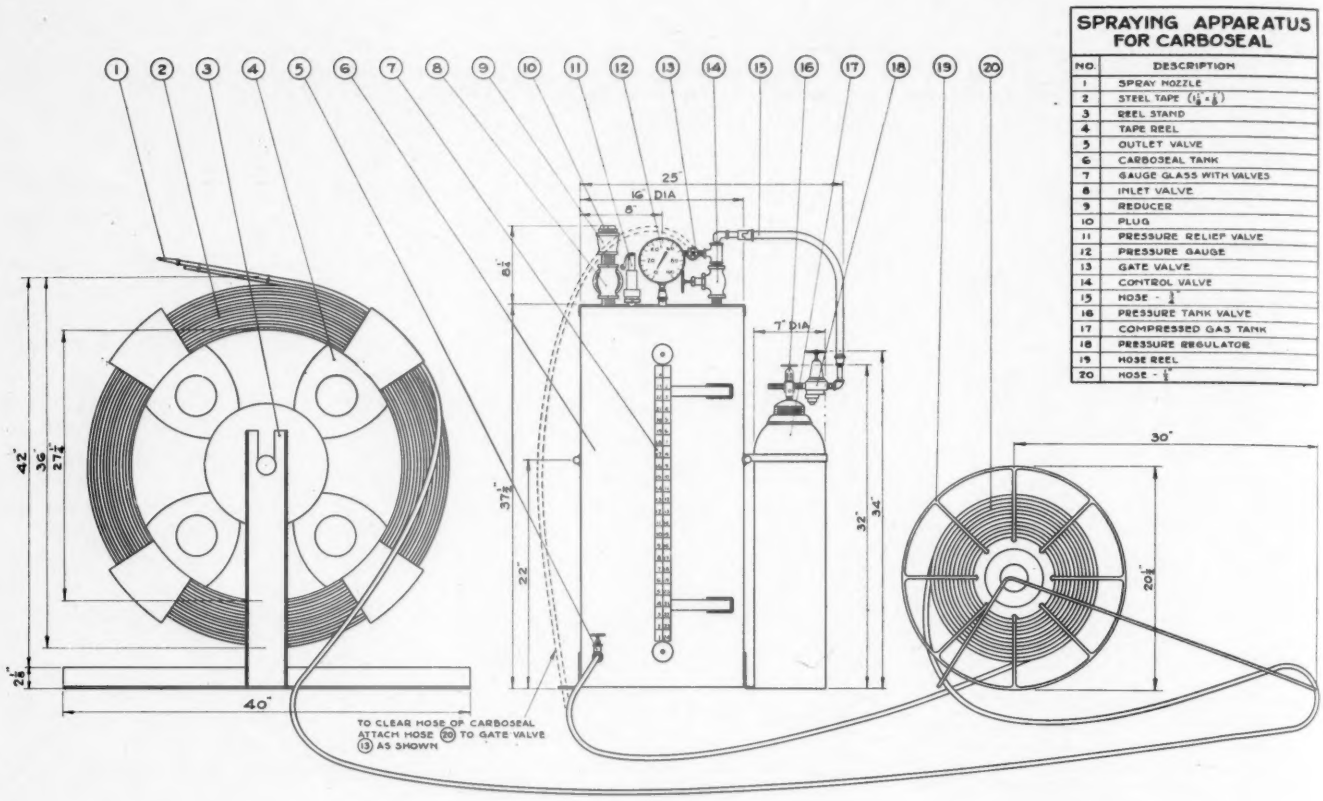
No single material was found to possess all of the desired properties. Some were too volatile. Some were too viscous. Some lacked climbing ability, and some failed to swell the jute fibres, or the swelling was insufficient to restore the packing to its original hydrated volume. A few were found to cause serious disintegration of the jute fibres and are therefore dangerous.

Characteristics

Carboseal anti-leak is a clear amber liquid with an inoffensive odor. Its specific gravity is 1.102 at 60° F. It weighs approximately 9.2 lb. per gal. The liquid has solvent properties for tar and gum and penetrates the packing material readily, swelling it approximately 45 per cent[1, 2, 3] by volume. It will climb to a vertical height of 24 in. in a joint. The material has the property of stiffening the jute and hemp fibres in the packing, which transmits the swelling action to all points of the packing mass, causing swelling of the mass as a whole, increasing the volume, and filling voids which permit escape of gas. In solution with water or undiluted, the material will not solidify down to temperatures of —58° F.

* *"Carboseal" is a registered trade-mark of Carbide and Carbon Chemicals Corp.*

Abstracted from paper presented at meeting of Natural Gas Section, American Gas Assn., Tulsa, Oklahoma, May 8-11, 1939.



The liquid has a high boiling point and an extremely low vapor pressure. Tendency to evaporate is negligible because of these properties and because the liquid is absorbed intimately into the jute fibres where the swelling action is produced. This material has been variously estimated by users to have a permanency of at least ten to twelve years. Joints in mains treated in March, 1933, and in contact with dry gas since that time, still remain tight on the soap test. The components of the material are inherently non-corrosive. Inhibitors have been added to provide corrosion protection.

Methods of Application

The most widely used method of applying the anti-leak is to insert it at the high points in the system, recovering for re-use the excess material which flows by gravity into the drips. Filling stations at the high points can be established by drilling and tapping the main. Theoretically, the amount required to treat a mile of 3-in. main or its equivalent is 265 lb. This quantity will saturate the packing, fill all the voids, and coat the entire inner surface of pipe which is free from dust and rust deposits. Actual experience over a period of years indicates that due to the presence of such factors as sags and dust in the main, the average total quantity required is 450 lb. per mile of 3-in. main or equivalent. The total cost of treatment including the liquid required, labor and materials, runs from $82 to $600 per mile of 3-in. equivalent with the weighted average in the neighborhood of $300 per mile.

* *Patented.*

Hose Method

In level systems where the mains are not sufficiently graded or where dust and rust deposits are excessive, it is preferable to spray the material into the main from a hose inserted through a tap. This method* has been described in the literature[1, 5, 7]. Many hundreds of miles of cast iron main have been treated with Carboseal anti-leak by the hose method with entirely satisfactory results. The apparatus generally used for this purpose is illustrated herewith.

The apparatus consists of a 110-ft. length of steel sewer tape 1⅛-in. wide and ⅛-in. thick, marked off every 10 ft. with a punch mark. One end of the steel tape is bent up at an angle of 30 deg. and a spray nozzle is welded flat to the turned-up end of the tape. This permits the tape to ride obstructions in the main and keeps the nozzle away from the bottom. A satisfactory hose is a 125-ft. length of 5/16-in. I.D.—¾-in. O. D. oxygen hose.

When applying, 1¼-in. or 1½-in. taps, depending on the size of the main, are made 200-ft. apart. A scale graduated to show the required amount of Carboseal for each ten feet of main is mounted on the gauge glass on the storage tank, a different scale being used for each size of main. The steel tape with the hose attached is pushed into the main until 100 ft. has been inserted. The valve is opened and the liquid is forced through the hose and nozzle by the pressure applied above the liquid in the storage tank.

Cost of Application

The following cost figures were reported by one company which treated 45.4 mi. of 3-in. equivalent main in one situation:—

Total 3-in. equivalent main treated	239,535 ft. or 45.4 mi. practically all under pavement
Total Carboseal used	3,135 gal. (29,200 lb.)
Delivered cost ..	$ 7,755.39
Cost of labor of application based on labor at 30 cents per hr.	$ 3,199.48
Paving cost—based on 13-ft. 2-in. by 1½-ft. ex-	

cavations per mile of actual main, irrespective of diameter	$ 5,828.04
Miscellaneous expenses This includes gasoline for the compressor and other miscellaneous expenses	$ 303.37
Total cost of treatment	$17,086.28
Cost per 3-in. equivalent joint, based on 450 joints per mi.	$ 0.833
Cost per actual joint (estimated number of joints —14,085) *irrespective of diameter*	$ 1.21
Total cost of treatment per mi. of 3-in. equivalent main	$ 376.30

The system is composed of the following: 1,925 ft. of 10-in main, 16,000 ft. of 6-in. main, and 150,000 ft. of 4-in. main. The joints are mostly lead joints, although there are some cement joints in the system.

Results

A great deal has been published about results secured by such applications in the field.[1, 2, 4, 5, 6] One large company began treating the entire cast iron portion of their low pressure distribution system in January, 1938. Treatment was 90 per cent completed in March, 1939. Some detailed information with reference to this particular case and results secured to date will be of interest:

Gas distributed	Natural
Miles of cast iron main in system 3-in. equivalent	103
Miles of steel main in system 3-in. equivalent	155
Total miles of main, 3-in. equivalent	258
Miles of cast iron mains treated prior to March 30, installed	650
1939, 3-in. equivalent	90
Number of filling stations	
Original estimated cost for completing treatment of 103 mi. of cast iron mains	$55,000
Present estimate completed job, based on 90 per cent completion	$45,000

This is a very level system. The grades of all mains were obtained by barring, and contour maps were prepared to show main pitch and drip locations. From these maps, points of application were selected and filling stations installed.

Initial applications of Carboseal were made according to the following table:

Size of Main, in.	*Lb. per 100 ft.*	*Gal. per 100 ft.*
3	25	2.5
4	33	3.3
6	49	5.0
8	66	6.6
12	90	10.0

A ½-ton truck was equipped with a 120-gal. storage tank connected to an ordinary kerosene dispensing pump which discharged 1 gal. of liquid with each turn of the handle. By a system of valve connections this pump was arranged to apply Carboseal from the storage tank or to pump it from the drips to the storage tank. The equipment required on the truck represented an investment of approximately $125. The storage tank on the truck was filled from the drums in which the material was shipped. Air pressure of 5 lb. per sq. in, was applied through a regulator to the surface of the liquid in the drum to effect transfer of the 55 gal. net content to the storage tank in one or two minutes.

The accumulated unaccounted-for (arrived at by comparing each month's figures with the same month of the previous year and adding the difference when it is above or subtracting when it is under) for the two years and nine months ending September, 1937, was 141,472,000 cu. ft. In the subsequent 18 months, this had been reduced to about 85,000,000 cu. ft.

Detailed cost figures for the job (90 per cent completed) are as follows. As previously mentioned, this property is level, and sags and dirt in the mains accounted for the greater than average consumption of Carboseal.

Carboseal	$22,200.00
Materials (pipe, fittings, etc.)	2,039.29
Labor (including proportional overhead)	13,382.00
Paving and misc.	1,606.45
Total	$39,227.74

This averages $436 per mile of 3-in. equivalent main treated. The total Carboseal anti-leak used was 116,800 lb. or 1,300 lb. per mi. of 3-in. equivalent main.

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Industrial Gas and the Competitive Angle

Part 4

Electricity, Butane, and Producer Gas

by
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Electricity

SO far in this series of articles on the competitive angle in connection with the sale of industrial gas, we have discussed the solid fuels, coal and coke, and the liquid fuel, fuel oil. In comparison with city gas we found these fuels to be less expensive on the Btu purchased basis, but due to their physical natures, far less efficient in application than gas. We found gas to be a refined fuel, and the one most easily subjected to control and most readily adaptable to different heating requirements.

We turn now, not to another fuel, but to a form of energy that is easily transformed into heat, namely electricity, a prominent factor many times in the competitive situation. Here the picture has been reversed; and we are now dealing with a source of heat far more expensive than gas as regards first cost, but on the other hand, one that has a greater efficiency of application than gas, by and large. This increase in efficiency arises from the virtual elimination of the stack loss inevitably associated with the fuels. When *fuels* burn, products of combustion are formed; and these must be removed from the furnace in order to allow further combustion to take place. Naturally these waste gases are hot; and their removal takes away heat, reducing the amount left behind for useful work. The higher the furnace temperature, the more heat goes up the stack and the lower the fuel "efficiency," a fact that helps make electricity an economical heating medium for the manufacture of steel and for other high temperature operations, although far from economical at lower temperature ranges. Expressed another way, the fuels have an "available heat" that decreases in direct proportion to the temperature, reaching zero at the flame temperature of that particular fuel (theoretically). Electricity, on the other hand, has the same available heat of 3,413 Btu per Kilowatt hour (disregarding small transformer losses) regardless of temperature.

In earlier days this higher efficiency of electricity was further increased by the better construction of electric furnaces as compared to the conventional fuel-fired furnaces. This was largely due to the much heavier insulation used in the former. Realizing that he had an expensive heating medium, the electric furnace manufacture tried to conserve every possible heat unit. Good design and thick insulation was a commonplace. In those days a fuel-fired furnace was merely a steel shell lined with fire brick. Insulation was little used and design in general was far inferior to present day practice. In many cases the efficiency of the electric furnace was so much greater than that of the glorified mass of firebrick used in connection with coal, oil, or even gas that it actually operated at less cost.

Now, however, times have changed. The electric furnace has been made but little better; while the fuel furnaces, particularly those in the gas field, have been greatly improved. Insulating fire brick has come into general use. Better advantage is taken of the mechanism of combustion, the mixing of fuel and air, their distribution in the furnace and their path through it. Today the gas furnace is conserving every possible Btu, stands comparison with the electric furnace from every angle, and then offers more, as we shall see.

Years ago gas was at a disadvantage for certain operations in which it was desirable that an electric immersion unit be inserted within the body of the material to be heated. Gas, on the other hand, had to be fired externally, with a resulting loss of efficiency and speed, an increased dross formation and a decreased kettle life. This caused gas to lose a great part of the newspaper stereotype pot load and threatened to drive it entirely from that field.

With the development of the gas immersion burner, however, this load was easily regained; and the gas industry found itself in possession of a new tool with which to withstand competition and enter new fields. Witness the radiant tube annealing cover for the bright annealing of strip steel, a field that electricity had threatened to monopolize. The same is true in the vitreous annealing industry where once the choice lay between electricity within the furnace or gas fired outside a muffle. Today the gas-fired radiant tube is inside the furnace, and the economics favor gas. Gas research has gone apace; and the factory manager of the present wishing new equipment is offered a far wider choice and a greater degree of engineering skill in the gas field.

So much for the advantages that electricity once enjoyed,—better engineered furnaces, internal heating, and freedom from combustion gases within the furnace. All problems that the gas industrial engineer and furnace manufacturer have successfully solved. Let us turn to the positive disadvantages of electric heating.

The first to consider, and often the controlling factor, is that of cost. The first cost of an electric furnace is usually greater than that of the corresponding gas furnace, a factor that usually means little, if lower op-

erating cost is linked with it. Lower operating cost is not, however, a characteristic of electricity furnaces. On the contrary, per purchased Btu electricity is the most expensive of all heating mediums found in the industrial field. Assume an electric rate of 1 cent a KWHr, then the cost per million Btu's is $2.93 or 29.3 cents a therm (100,000 Btu's). Soft coal at $5 a ton is roughly 2 cents a therm. Coke at $8 a ton is 3 cents a therm. Oil at 6 cents a gallon is 4.3 cents a therm. Natural gas at 50 cents a thousand (1,000 Btu gas) is 5 cents a therm. Manufactured gas (550 Btu) at 80 cents a thousand is 14.4 cents a therm. Hence there is a tremendous difference in cost for electricity to overcome.

We found in the previous articles that gas overcame a price difference. Why can not electricity do likewise? Admittedly it has a higher operating efficiency. The answer lies in the fact that electricity can not offer sufficient advantages in control, safety, cleanliness, flexibility, service and availability over gas to overcome the price differential. The control of the gas flame manually or automatically is in no way inferior to that of electricity. Safety is a standoff, with both mediums amply protected. Cleanliness is certain with gas properly used. Flexibility is a property of gas combustion that is lacking with electricity. A throttling of heat input, easy with gas, is difficult with electricity.

Flexibility from the standpoint of available equipment and a number of ways of heating a certain material belongs to gas exclusively. Service is again a standoff, public utilities serving both. Availability again favors gas. Gas is always on the line come hurricane, storm, fire or flood. Only an earthquake, and a sizable one at that, threatens the constant supply of gas. Electricity on the other hand is more or less at the mercy of the elements, and freedom from interruption can seldom be guaranteed. Thus electricity has little to offer as compared to gas to justify a higher fuel cost.

Turning from the negative to the positive side, we find that electricity has certain definite disadvantages that make it undesirable for certain purposes regardless of price. Thus, research has shown that in a low temperature oven heating a number of items, such as a core oven, gas gives a far better, more uniform bake. This is due to the fact that the gas heating is largely by convection, while the electric heating is largely by radiation.

It is a law of nature that radiant heat travels in straight lines, and has practically no heating effect on the atmosphere through which it passes. However, it is absorbed by the solids directly in its path, the degree of absorption being measured by the black body coefficient of the material. Most solids, other than polished metals, absorb some 90% of the radiant heat striking them. Thus the work that faces or "sees" the electric heating elements is heated far faster than the work that is "shadowed." This means, of course, uneven heating.

Gas, on the other hand, gives off but a small amount of radiant heat (at least with the type of burners used in such ovens); but sets up currents of warm air and stack gases that sweep up through the mass, blanketing every piece and heating all at the same rate (assuming proper design, the responsibility of the industrial gas engineer).

Another undesirable feature connected with electric furnaces is the lack of atmospheric control. The electric furnace is always oxidizing of itself, since the work is carried on in normal air surroundings. In the heat treatment of steel such an atmosphere is usually to be avoided. To prevent oxidization and excessive scaling of the work, artificial atmospheres have to be introduced—nitrogen, city gas, hydrogen, etc., an expensive complication. Gas-fired furnaces, however, by a simple adjustment of the air-gas ratio can furnish an oxidizing, a reducing, or a neutral atmosphere that meets most cases and does so with only a small sacrifice in the furnace efficiency.

In general, to meet electrical competition the best plan is to educate the prospect in the tremendous advances that industrial gas has made in the last few years. Tell him of the far-reaching research programs that have been, and are still going on. Show him the new types of equipment that have come into common use. Give him a picture of the many types and systems of gas-firing available. Let him see that you can draw upon an immense fund of engineering knowledge possessed by the manufacturers of gas furnaces in order to meet and solve his particular problem. Impress him with the aggressiveness and vitality of the industrial gas industry. Then talk comparative costs. You may be sure that your competitor, if he is on his toes, will have done his best in advance to discount your figures and fill the prospect's mind with the wonders of electricity, with perhaps a sly reference to the dying gas industry. Prove its wideawakeness, and you will be in the driver's seat.

Butane, Propane and Other Liquefied Petroleum Gases

Having discussed the more common of our competitors, we turn now to a series of fuels less frequently encountered, namely butane and the other liquefied gases. Although less common, their competition, when we do meet it, is a real problem, as their physical natures are the same as that of our fuel, and the same advantages in handling and application apply.

The two most common are butane, C_4H_{10}, sold under the trade designation of G-4, and propane, C_3H_8, sold as G-3 and, on a smaller scale, as the typical bottled gas of commerce, under a whole series of proprietary names such, for example, as "Pyrofax." These substances are hydrocarbons belonging to the same family as methane, CH_4, the main constituent of natural gas. The so-called paraffin series runs as follows:—

Methane	CH_4
Ethane	C_2H_6
Propane	C_3H_8
Butane	C_4H_{10}
Pentane	C_5H_{12}
Hexane	C_6H_{14}

following the formula C_nH_{2n+2}. At the lower end of the scale, methane and ethane are gases at ordinary temperatures and pressures. At the upper end, pentane and hexane (the major constituents of gasolene) are liquids. Propane and butane are "neither fish, nor fowl, nor good red meat." Propane boiling at —44° F. and butane at +30.9° F. at atmospheric pressure can be liquefied by pressure (124 lbs. per sq. inch at 70° F. for propane and 31 lbs. per sq. inch at 70° F. for butane) and shipped in proper containers as liquids.

Propane, calling for greater pressures for its liquefication than butane, requires heavier containers and thus greater transportation charges per gallon. It is therefore usually shipped in small cylinders; and selling at a premium over city gas, it is used chiefly as a domestic fuel beyond the mains of the gas companies. Butane on the other hand can be shipped in special tank cars and is sold in quantities and at prices highly competitive

Fig. 1. Two rack type core ovens. Oven on left was originally electrically heated. After installation of right hand oven on gas and comparative tests, the left hand oven was converted from electricity to gas as shown.

Fig. 2. Toasting end of battery of four breakfast cereal ovens. Originally electrically heated, they were converted to gas by means of high pressure velocity burners firing into alloy tubes above and below the conveyor belt that carries the cereal.

with any but very cheap natural gas.

These gases are obtained from "wet" natural gas and as a by-product in the refining of oil. In the absorption process of treating wet natural gas, the gas is washed with an oil of very low volatility. This absorbs the heavier hydrocarbons, leaving only the low boiling point gases, such as methane and ethane. Then upon distillation, this scrubbing oil gives up the absorbed hydrocarbons in relatively pure fractions. The pentane, hexane, and higher paraffins are liquid, and are sold as natural gasolene. The propane and butane fractions are too "wild" for such purposes and hence must be marketed elsewhere.

Propane has a heat content of 2522 Btu per cubic foot or 91,500 Btu per gallon. Commercial butane runs 3261 Btu per cubic foot or 102,600 Btu per gallon. A tank car of the latter holds approximately 10,250 gallons or the equivalent of 1,912,000 cubic feet of 550 Btu city gas. The selling price varies with location and freight rate, but is usually well under manufactured gas prices.

Much butane is sold today as the base material for manufactured gas in small communities where the demand does not justify the heavy initial investment and operating costs of a coal gas or water gas plant. Butane is received in tank cars, unloaded as a liquid into storage tanks, and piped as needed through a pressure regulator to a vaporizer. Here a small amount of heat at low temperature supplies the necessary heat of vaporization. The butane vapor is then automatically mixed by means of a proportioning machine with the proper amount of air to reduce the heat content of 3200 Btu per cubic foot straight butane to a 500-600 Btu mixture. Thus the gas supplied to the consumer is a little over 80% air by volume, with a specific gravity of 1.15—1.17. It is distributed and utilized in a fashion little different from that of any other manufactured gas.

When used industrially this same method of generating a 500-600 Btu gas may be used, or the butane vapor may be piped to the furnaces undiluted. The latter method saves an investment in equipment and a certain amount of attention, and is perhaps the more common.

The main disadvantages of this fuel are two. First, the heavy initial expense involved. Storage of the liquid must be under pressure, and a complete storage system is very costly. Installation and equipment costs are high. For the small plant the investment required makes butane out of the question. Since a single tank car represents nearly 2,000,000 cubic feet of city gas it is after all a large scale undertaking. Even for the large plant, the construction of a fireproof building at a distance from the main plant, the purchase of storage tanks, equipment for vaporizing, control, and piping represent a major investment with accompanying capital charges that must be seriously considered.

The second grave disadvantage is from the safety standpoint. Several problems are involved. In the first place butane vapor has a specific gravity of 2.01 as compared to air, meaning it is twice as heavy as air. Hence any leakage of gas is not readily dissipated, but remains at the bottom of the pipe trench or collects in pockets or pits ready to ignite. This danger is aggravated by two other properties of butane, its lack of odor and its low explosive limit. Butane is odorless and colorless; and unless an odorant is added, it is very difficult to detect when present in small quantities. Furthermore, only small quantities are needed for an explosion, as the lower explosive limit is but 1.9% of butane vapor in air. All these facts mean higher insurance rates and the need on the part of factory management to exercise special precautions to prevent possible serious consequences.

Other possible minor disadvantages come to mind, such as the question of supply. Shipment is via railroad, with the source of supply sometimes many hundred miles away. The possibilities of an interruption must be considered and adequate reserves kept on hand. The matter of stability of price also arises. Neither public utility commission nor a fiercely competitive market is available as control. Finally the matter of service, of local engineering help on furnace and fuel problems that the gas industrial engineer so freely gives is no longer to be found.

In summary, the smaller plant definitely can not afford butane, while with the larger plant it is decidedly a question whether the possible fuel saving outweighs the disadvantages from safety and other angles.

Producer Gas

The last fuel to be taken up and perhaps the least important from the competitive angle is producer gas. Here again, as with butane, we are discussing a type of competition limited to the largest plants by reason of the rather considerable initial investment required, as well as the sizable output of even the smallest unit.

Producer gas is made by blowing steam and air through a bed of incandescent coal or coke. The resulting gas consists mainly of nitrogen, carbon monoxide and hydrogen, with small amounts of carbon dioxide, methane, and oxygen in that order. The heating value per cubic foot is low, averaging around 150 Btu for the coal fired and 130 Btu for the coke fired producers. The typical producer is a brick-lined steel shell with an internal diameter of 10 feet, having a capacity of 36 tons of coal a day. Roughly the gas produced represents 75% of the heat input of the coal, with its sensible heat making up another 11%. Thus the output runs approximately 134,000 cubic feet a ton, or 4,824,000 cubic feet in 24 hours (154 Btu/cu. ft.).

At prevailing prices, the modern producer gives gas costs running between 30 and 40 cents per million Btu's or 3 to 4 cents a therm. The lower figure represents the use of the hot dirty gas or credit for waste heat boilers. This cost takes into account fuel, labor, and capital charges and assumes continuous operation throughout the year, 24 hours a day. Naturally this means a real production schedule and a gas demand practically constant in quantity. The steel and glass industries are among the few whose demand is large enough and steady enough to meet these requirements. In one local plant on automotive work, where a rather ancient producer held forth, management priced the gas produced at 15 cents a thousand, or some 9 cents a therm. The gas was used in annealing furnaces; and comparative tests with our 900 Btu mixed gas, using better (automatic proportioning) burner equipment, showed a Btu replacement with our gas of 1 Btu to 1.32 Btu's of producer gas.

Two other local plants, one a large bakery and the other a vitreous enameling plant, shut down their producers and switched to a 900 Btu. mixed gas selling at 6.7 cents a therm without hesitation once they were assured of the dependability of supply. Although they did not reveal their costs on producer gas, they both stated they were much better off in every way after the change.

To get the maximum efficiency from a producer the gas must be used hot and dirty, just as it leaves the retort. If this is done, it tends to clog up lines and burners, making necessary frequent shutdowns for cleaning. Further, the gas contains so much sulphur that it appreciably shortens the life of pipinge and burner equipment. If on the other hand the gas is cleaned and cooled, only three-fourths of the heat in the original coal is made available (barring the use of waste heat boilers).

Producer gas, due to the high percentage of inerts it contains, has a lower flame temperature than the other fuel gases; and its use is sometimes limited for high temperature, applications on this account. Also its analysis depends on many factors, type of fuel charged, depth of fuel bed, frequency of charging, size of fuel, rate of firing, ash removal, and amount of steam and air blown in. Hence uniformity is apt to be lacking unless there is considerable careful supervision.

With most plants the task of manufacturing its own product in the most efficient manner and at a cost that will return a fair profit is enough of a problem without saddling themselves with a gas manufacturing plant. The larger steel plants, skilled in the generation of fuel gases, operating 24 hours a day year in and out, able as a rule to use the hot, dirty gas, may well be exceptions; but few others will find it profitable, all considered, to embark in the gas business. After all, every man to his trade and, there being tricks to all trades, let those whose business it is struggle with the burdens of producing fuel.

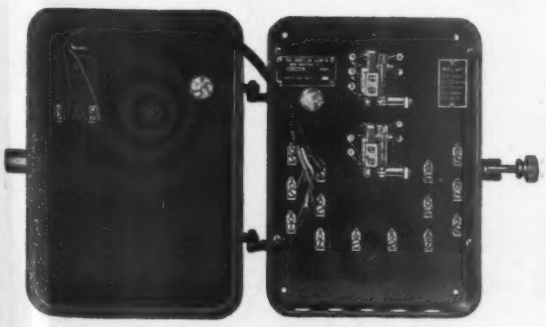
Summary

In these four articles the writer has attempted to cover the competitive situation as the industrial gas engineer meets it. Against competition, it is salesmanship and not engineering that counts; but certainly salesmanship in this case must be built on an understanding of the engineering principles involved.

Economics of City-Gas-Oxygen Cutting Torches Slated for Analysis

Metal cutting and welding with city-gas-oxygen torches; recent advances in the use of prepared gaseous atmosphere furnaces; and new heat treating processes which have come over the horizon in the past year; were the three subjects singled out for study and analysis during 1939 by the Ferrous Metals Committee, Industrial Gas Section, American Gas Association, at a recent New York meeting. New Chairman of this group acting in behalf of improved applications of gas to the iron and steel industry's heating jobs, is Clayton S. Cronkright, Public Service Electric and Gas Company of New Jersey.

Paramount in the Committee's mind this year will be the economic considerations involved in the use of city gas in the three fields noted. Actual cost studies of numerous applications will be made. Several and frequent Interim Bulletins will be issued to disseminate useful data to the trade.



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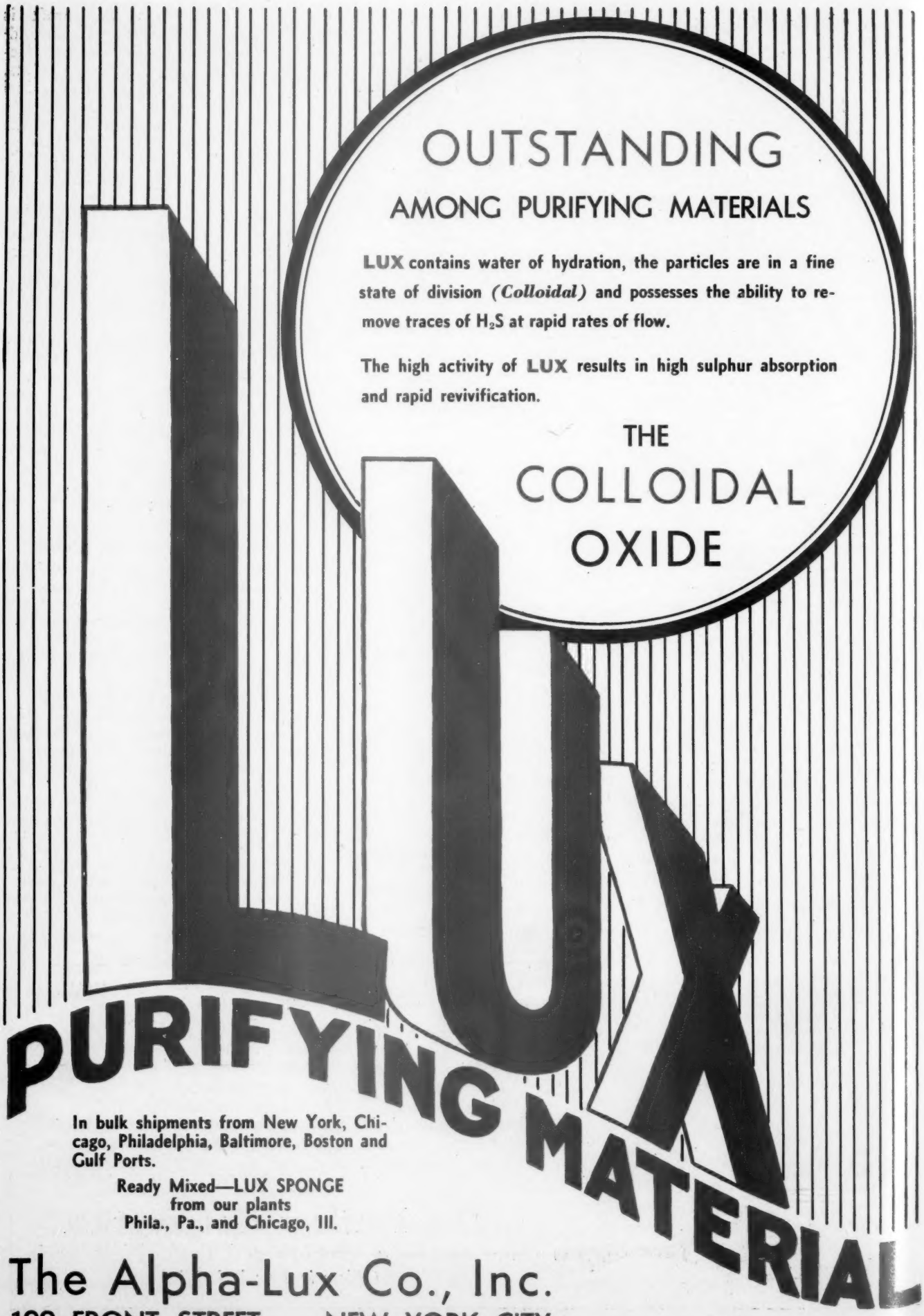
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Practical Control Methods for Operation of Gas Purifiers*

By

E. L. Sweeney

Boston Consolidated Gas Company
Everett, Massachusetts

THE term gas purification, as generally used, considers the removal of sulfur compounds that pass by the condensing and scrubbing apparatus. Iron oxide is principally used for the removal of H_2S and the scope of the work presented in this paper outlines methods which will be helpful to efficiently utilize the factors governing oxide purification.

Summary

The main factors in the successful operation of a purifying system are an adequate supply of air varying from 3% to 10% of the hourly make, depending upon the concentration of H_2S; the use of a normally active oxide; and the uniform distribution of the material in filling the box.

For economical operation a capacity of 5000 bushels of active oxide; or 6000 bushels of normal oxide, per million cubic feet of maximum day output is satisfactory. A flow of gas equivalent to 30—50 cubic feet per hour per bushel of oxide in the first box is desirable.

The admission of steam is necessary for effective control of the oxide moisture and to maintain a working gas temperature between 90° and 100° F.

A mixture of approximately 2 volumes of carrier to 1 volume of ore produces a satisfactory surface area.

The concentration of oxygen in the outlet gas should be 0.5%—1.0%.

In any series it is desirable to have at least one new oxide and one on second fouling in service.

Operating forward rotation the end box should contain fresh oxide.

A discharged box should be thoroughly cleaned and flushed before filling.

Material used is a function of sulfur removed.

Oxide beds dumped are a function of days clean.

Labor cost is a function of boxes changed.

Recommendations

It is recommended that the sulfur content of the oxide, the flow of gas per hour, daily quantitative and qualitative test of the work done by each box, by means of the Tutweiler apparatus and test papers, inlet and outlet temperature of each box, the number of days of clean paper tests, the differential box pressure, and the % air, be kept in an orderly record. This record will show at a glance the condition of each bed of oxide and work of the boxes in use at any time.

Principal Factors Governing Oxide Purification

- Selection of Material
- Filling of Boxes
- Use of Carrier
- Operation of Boxes
- Revivification
- Sampling and Analysis of Material
- Control Records
- Costs

Selection of Material

The selection of purifying material is very important. (1) It must contain water of hydration, the particles must be in a fine state of division and possess the ability to remove traces of H_2S at rapid rates of flow. The greater the colloidal properties of the oxide the more active it will be due to the increase in surface area exposed to the gas. The finished product should weigh between 30-40 pounds per cubic foot for shaving oxide and between 40-50 pounds per cubic foot for slag material, with a free moisture content of 40% to 50%.

Several scientific laboratory methods have been developed to evaluate oxides. (11) (12) Laboratory tests of an oxide in general are of minor value, because it is impossible to reproduce the surface conditions that exist in plant boxes. The laboratory activity test, however, is helpful in selecting material. Fig. 1. shows test curves illustrating activity of oxide.

It is desirable to obtain information concerning the experience of others in the use of material, allowing for the fact that operating conditions are decidedly different at each plant.

The final decision in evaluating the qualities of several oxides should be made from actual plant use, where conditions remain the same.

Since the water content of ready made material, natural ore and precipitated ore is quite variable, purchase should be made on a moisture content basis. The correct formula for adjusting moisture content is as follows:

Purchased Water basis = 50%.

% Free moisture in material received, dried to constant weight at 105° C = 55%.

$$\text{Correct weight at 50\% moisture} = \frac{\text{Tons rec'd} - (.55 \times \text{Tons rec'd})}{100 - 50} \times 100$$

Filling of Boxes

The filling of boxes is also an important operation and great care should be exercised in levelling off the oxide mixture to prevent thin spots or coarse material collecting at the edges. The oxide should be tamped continuously to avoid openings that occur due to shrinkage and irregularities at the tray supports. Each layer should be of equal depth with uniform distribution. The filling chute or grab bucket should be maneuvered to prevent the oxide falling on the trays from packing into a solid mass, which would cause channelling. To prevent gas by-passing the material it is advantageous to blank the trays with matched boards 12 to 18" around the box edges at each tray layer. The sides of the box should be thoroughly cleaned of old oxide and the bottom flushed before filling.

Use of Carrier

Shavings are universally used as a carrier for oxide of iron. It is important that they be fairly uniform in size and preferably of soft wood, because of the water retaining quality of this kind of wood. To secure rapid reaction, it is necessary that the interfacial surface be of an enormous area. Experience shows that a proportion of two volumes of carrier to one volume of ore results in satisfactory sulfiding.

* *Presented before the Joint Committee Conference of the Production and Chemical Committee, Rochester, N. Y., May 22-24, 1939.*

Success with blast furnace slag (9) as a carrier depends upon the physical characteristics and density of the material. In general the slag should weigh between 15-20 lbs. per cubic foot dry, be of uniform size and porous (water granulated). Above 25 lbs. per cubic foot the weight is excessive, the structure is not sufficiently porous and produces channelling, below 15 lbs. per cubic foot it is quite fragile and breaks down in storage and handling.

Operation of Boxes

Arrangement

The purifying system should be valved so that any single box can be shut off for the change of oxide and in addition allow rotating any number, backward, forward, or reverse flow. If more than one series is used they should be inter-connected to permit any parallel-series combination.

Equipment

Orifice Meters inlet each series.
Thermometers, long stem, range 20-120° F., in inlet and outlet of each box.
Differential pressure gage on each box.
Recording pressure gage inlet and outlet of each series.
Steam connection inlet main and under each layer of oxide.
Suitable blower for adequate air supply.
Test pipe, (brass) inlet and outlet of each box.
Tutweiler apparatus and test solution.
Insulate exposed piping on outdoor boxes.

Temperature (7)

The activity of an oxide increases with increase of temperature, and a range between 90°-110° F. controlled with exhaust or live steam injected into the inlet gas main has been found satisfactory.

Oxygen (6)

Oxygen is necessary to aid purification in place, the % air depends upon the type of oxide used and the concentration of H_2S. Satisfactory results will be obtained if the oxygen in the outlet gas is maintained above 0.5%.

Flow of Gas

The rate of flow should be as high as possible. It depends upon the kind of oxide used and the concentration of H_2S. If the material is of normal activity a rate as high as 50 cubic feet per hour per bushel of oxide in the first box can be used. A rate below 30 cubic feet will, in most cases, eventually result in traces of H_2S passing the system. This phenomenon is more than likely due to the thickness of the water and gas film on the surface of the oxide particles which is affected by the velocity of the gas. The diffusion rate of H_2S through this film is the controlling factor.

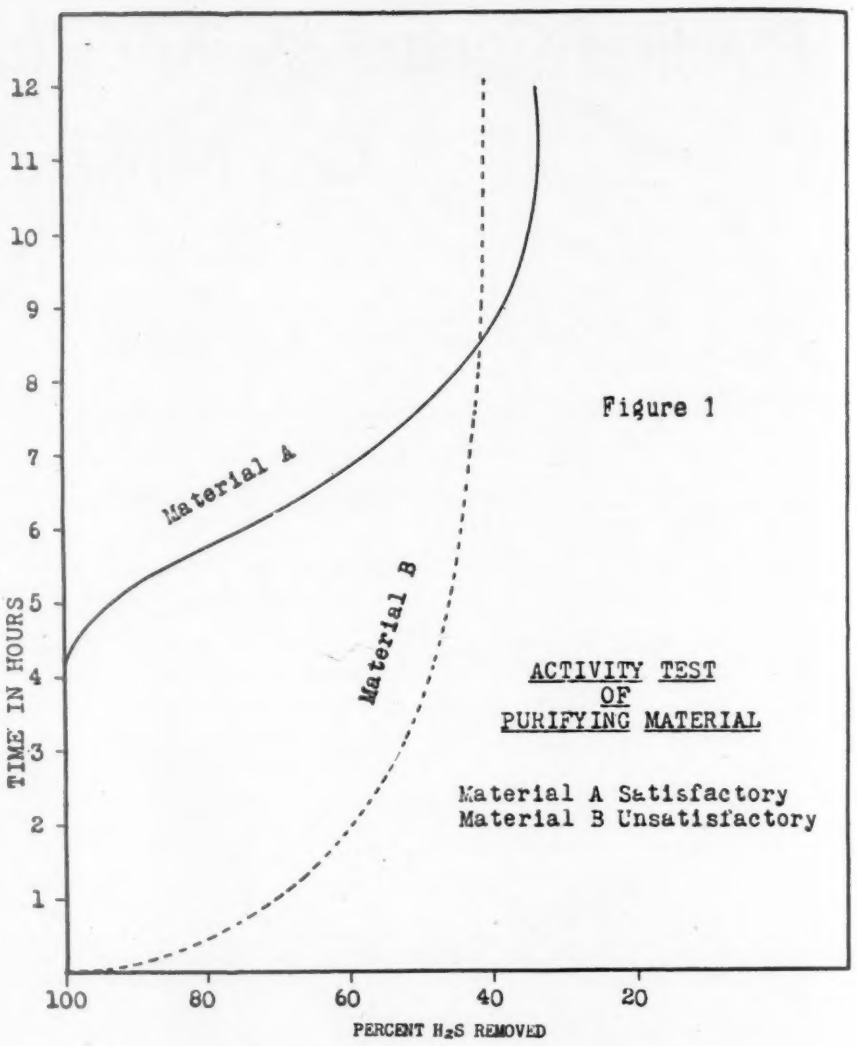


Figure 1

Moisture (3) (5)

The moisture content of the oxide is an important factor in the removal of H_2S. A deficiency will cause the activity to fall off sharply and eventually traces will pass through the system. The longer the service of a box before dumping, the more important is the control of the moisture content of the oxide.

A rise in temperature through the system usually indicates either excess oxygen, or a deficiency in moisture, sometimes both. This condition will cause the oxide to become caked, dry and inactive, except in a few instances where the gas entering is saturated and the interval of time between dumpings is comparatively short.

The injection of steam into the inlet gas main is a convenient method of carrying moisture to the oxide. In addition steam may be used between the layers. The control is best regulated from observation of the moisture condition of the discharged beds. In cases where it is evident that the oxide is dry and a bed is to be discharged, the series should be rotated backward until the sulfided bed is on last. This will allow some deposition of moisture which will prevent a fire occurring.

Box Removal

A series can be operated with safety until the outlet box is showing a trace on basic lead acetate test paper. This will occur about two weeks before the standard lead acetate paper test is dirty. At this time a decision should be made as to which box is to be dumped.

Daily Observations

The removal of H_2S by each box, from Tutweiler determination, paper test with basic lead acetate, on the end boxes, the inlet and outlet temperature, and pressure of each box, should be recorded daily. The average hourly flow of gas should also be

recorded, and if more than one series is operated, the installation of orifice type flow meters is essential to measure the flow to each unit in service.

Sensitive Basic Acetate

50 grams of lead acetate per liter made basic with NaOH until the precipitate first formed is dissolved. This solution stains light brown at a concentration of less than 0.04 grains of H_2S per 100 cubic ft. It is about 10 times as sensitive as the standard lead acetate paper tests.

Revivification

A sulfided bed should be revivified immediately after discharge to prevent overheating. Whenever possible it is better to use mechanical equipment to process the material. The usual procedure is to break the lumps with hand labor, convey the oxide to a crusher, and then to a mechanical conditioner. Experience will dictate the necessity of repeating the procedure. Mr. F. T. Turner in the AMERICAN GAS JOURNAL 1931 pp. 58-9 outlines in detail the Mechanical Revivification of Oxide Material.

Methods of Analysis and Tests

Sampling

The sulfided bed should be sampled after it has been cured. Suitable grinding, quartering, and sifting equipment should be available. The grinder should have 2 mm., 1 mm., ½ mm., and 40 mesh or 0.28 mm. screens. The following procedure is recommended for accuracy:

1. Sample bed in the usual manner to not less than 300 lbs.
2. Turn, mix, spread out and quarter to 75 lbs. for Laboratory sample. This 75 lb. sample approximately ½".
3. Dry for grinding.
4. Grind 75 lb. sample to 3 mesh (p. 199 inch = 5.05 mm.)
5. Mix and quarter (18.8 lb.).
6. Grind 18.8 lbs. to 6 mesh (0.082 inch = 2.08 mm.).
7. Mix and quarter (2.35 lbs.).
8. Grind 2.35 lb. to 12 mesh (.043 inch = 1.09 mm.).
9. Mix and quarter to (0.59 lb.).
10. Grind to 22 mesh (0.52 mm.).
11. Mix and quarter to 0.15 lb. = Laboratory sample.
12. Grind 0.15 lb. to 40 or 60 mesh.
13. Dry 0.15 lb. to constant weight at 95° C. in oven.
14. Keep 0.15 lb. sealed in bottle.
15. Mix and quarter 0.15 lb. sample to 0.50 or 0.75 gms. for analysis.

Analysis

Moisture (14)

Weigh 50 to 100 grams, depending on the moisture content of the material and dry at a temperature of 105° C. to constant weight.

Total Sulfur

This method makes use of the Parr sulfur bomb. Complete directions for the assembly of the bomb and its operation are supplied by the manufacturer. The following method has been found to give excellent results:

Weigh accurately 0.5 gram of the dry, finely ground sample. Fill the measure (supplied with the apparatus) with C.P. (sulfur free) sodium peroxide and place the contents in the fusion cup. Transfer the oxide sample to the fusion cup and mix carefully with the peroxide, using a dry platinum wire or stirring rod. In mixing, be careful to avoid scraping the fusion cup too vigorously as this may cause premature ignition of the mixture; especially with high sulfur, shaving oxide.

Next add one level teaspoonful of nitrated filter paper accelerator. (A sufficient quantity of this for several determinations may be made at one time by digesting qualitative filter papers with nitric acid in an evaporating dish on the steam bath). After digestion, dry and break up to a fine powder.

Mix the accelerator with the top layer of the mixture leaving some of the mixture on top.

Attach a three-inch length of the special iron fuse wire (supplied with the apparatus to the terminals of the bomb cover), making a hook which will dip into the fusion mixture.

Assemble the bomb, place in the water bucket provided, and fire in the usual manner. Allow the bomb to remain in the water until cooled to nearly room temperature, then remove, open and remove the fusion cup. Remove the cover and wash any material adhering to it into a 400 ml. beaker. Carefully place the fusion cup on its bottom in the beaker, cover with a watch glass, and upset the cup. When the vigorous reaction has subsided, wash the cup thoroughly with hot distilled water into the beaker, holding the cup with crucible tongs.

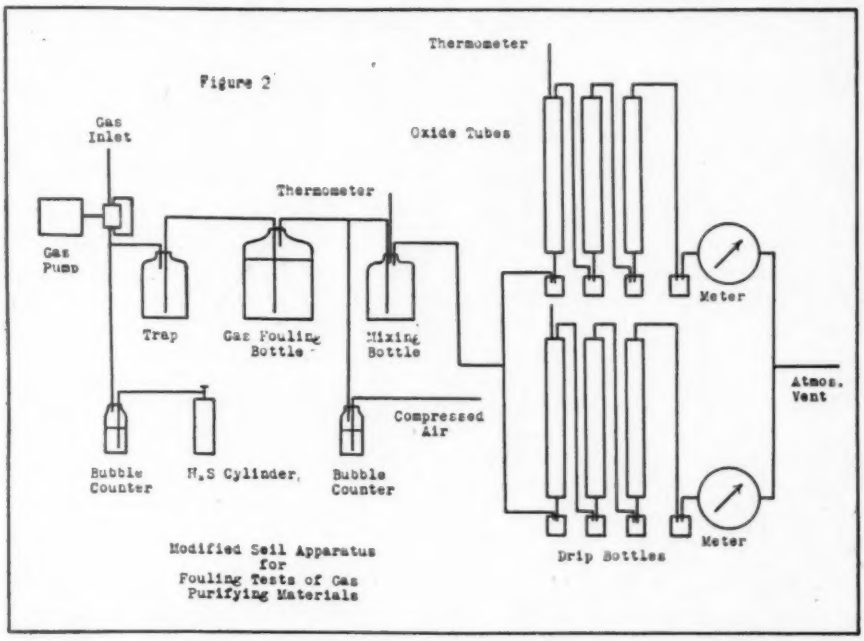
Acidify with concentrated HCl, heat to boiling, remove from the heat, add about ¼ teaspoonful of 20 mesh aluminum powder to reduce the ferric chloride to the ferrous state. When the color changes from yellow to colorless, filter through No. 50 Whatman's filter paper and wash with distilled water. Add 50 ml. of 10% $BaCl_2$ solution and place on the steam bath until precipitation is complete (preferably overnight). Filter, using Whatman's No. 44 filter paper, wash with hot distilled water until free of chlorides, ignite in a platinum crucible, and weigh as $BaSO_4$. The total sulfur content of the oxide is then calculated as follows:—

$$\frac{\text{Wt. } BaSO_4 \times 0.1374}{\text{Sample Wt.}} \times 100 = \% \text{ S}$$

Free Sulfur

Weigh 5 grams of the dry, finely ground sample on a watch glass and heat in a drying oven at not over 95° C. to constant weight in order to remove the last traces of moisture. Transfer to a Soxhlet extraction thimble and extract with C. P. CS_2 until extraction is complete collecting the extract in a weighed flask. Distill off the CS_2 on the steam bath through a Leibig condenser. Dry the residue at not over 100° C. The

Figure 2



Modified Seil Apparatus for Fouling Tests of Gas Purifying Materials

Form 354 250 7-38

BOSTON CONSOLIDATED GAS COMPANY

HYDROGEN SULPHIDE

COAL GAS MONTH OF_____

DATE	No. 2 HOUSE			WEST SIDE			OUTSIDE BOXES			REMARKS
	FLOW	IN	OUTLET	FLOW	IN	OUTLET	FLOW	IN	OUTLET	
1										
2										
3										
4										
28										
29										
30										
31										
AVE.										

Figure 3

weight gives the amount of tar and free sulfur.

Add to the flask 50 ml. of fuming HNO_3, evaporate on the hot plate to half its volume, then add, little by little, 3 grams $KClO_3$, and evaporate to dryness. Bake on the hot plate for ½ hour, cool and add 30 ml. of 1:1 HCl. Boil, filter, and wash with hot distilled water. Heat the filtrate to boiling and add slowly a boiling 10% solution of $BaCl_2$ in excess. Boil for one-half hour, or let stand overnight on the steam bath, filter hot, wash with hot distilled water until free of chlorides, ignite in a platinum crucible, and weigh as $BaSO_4$ in the usual way.

$$\frac{\text{Wt. } BaSO_4 \times 0.1374}{\text{Wt. Sample}} \times 100 = \% \text{ S}$$

Tar

The weight of sulfur subtracted from the weight of CS_2 extract gives the weight of tar.

CS_2 is very inflammable and in the gaseous state, when mixed with air, is highly explosive. The extraction apparatus should never be disconnected until it has cooled down to room temperature.

pH of Oxide (14)

Fill an 8 ounce, wide mouth bottle half full of the oxide ore or oxide. The sample does not need to be dry or finely ground. Add distilled water until the bottle is nearly full. Stopper, and shake well at frequent intervals and allow to stand overnight. Filter and use the La Motte block or Roulette comparator to determine the pH value of the material.

Water Soluble Alkalinity

A convenient and accurate method of determining alkalinity, developed by Frank H. Dotterweich and Wilbert J. Huff (12) is as follows:—A 1 gram sample of the oxide is placed in a 200 cc. bottle containing 50 cc. of distilled water and shaken for one hour. Allowed to stand until a clear solution results, then a 100 cc. portion of the clear liquid is withdrawn and titrated with dilute hydrochloric acid using methyl orange as an indicator. From this titration the alkalinity is calculated as per cent by weight of sodium carbonate.

Iron

A convenient and accurate method for the determination of iron may be found in Dr. G. E. Seil's manual of the Chemical Analysis of Purifying Material. (14)

Activity and Capacity (Fig. 2)

The method for determining activity and capacity of oxides developed by Seil (11) has been found to give results which are, on the whole satisfactory. It has been noted however, that the rate of flow employed (9 cubic feet per hour) tends to favor highly active oxides unduly. By reducing the rate of flow so as to yield a space velocity (cubic feet of gas per cubic feet of purification material) more nearly approximating that in the plant, a better comparison may be obtained. (13)

This method, like any small scale test, is of value when a number of samples are to be compared, or when the value of the material under consideration is so doubtful as to make the purchase of a sufficient quantity to fill a box inadvisable. (8)

Frank H. Dotterweich and Wilbert J. Huff (12) have also developed an accurate and satisfactory laboratory test for the determination of the activity of purifying material, with particular reference to the colloidal properties of the oxide.

Records

Monthly

Fig. 3 shows a convenient form for recording the daily observations of H_2S removal, temperature, and pressure conditions. A separate sheet is used for each observation and summarized as a monthly average.

Weekly

Fig. 4 shows a chart of a permanent and continuous record of the H_2S removed by each box in a series, calculated weekly. The total H_2S at the inlet is obtained by adding the H_2S removed in each box. The average hourly flow for the month and the number of days the boxes are cleaning traces is also recorded. Analysis of the data will indicate whether the first box should be dumped, the trace box removed, and refilled, or the series rotated when H_2S is found passing through the system. The information will show at a glance the condition of any box in service.

Fig. 5 is a chart form showing the sulfur content in thousands of pounds for each oxide bed in service, the % sulfur, and the rate of sulfur accumulation. The data is prepared weekly.

Fig. 6 is a nomograph to facilitate calculating the amount of sulfur from the flow and H_2S removal.

Fig. 7 is a nomograph prepared to calculate the % sulfur in each bed on a dry basis. The dry weight of the bed taken from the batch record of the oxide corrected for the additional weight, due to the accumulation of organic matter.

A study of the charts in Fig. 4 and Fig. 5 will show the condition of each oxide bed in service at any time. A tentative dumping schedule can be arranged, which is a valuable aid towards distributing labor on plant jobs. An approximate budget for new material as well as a schedule of shipment when needed may also be set up.

Oxide Bed

Fig. 8 shows a convenient form for recording the history of each bed of oxide. This should be a routine record filed for permanent reference. It consists of an analysis of the material used on a dry basis, the moisture content, the total cubic foot weight of the material on an as received basis, the total weight of the bed reduced to a dry basis, % sulfur absorbed, dry basis, cost of the oxide including labor and handling charges previous to use, and direct expense for box changes, curing and discarding. In addition miscellaneous data such as % H_2S removal when the bed is dumped, the pH and moisture of the oxide in and out, the average flow of gas per hour, and the pounds of sulfur removed per pound of ore.

PREDETERMINE COST OF GAS PURIFICATION:

"IN ALL CASES WHERE GAS PURIFYING PRACTICES BE SUCH AS ARE RECOGNIZED AS STANDARD . . .

E. J. LAVINO AND COMPANY WILL GUARANTEE A DEFINITE MAXIMUM COST PER POUND OF H_2S REMOVAL USING LAVINO ACTIVATED OXIDES"

How To Get Your Guarantee:

Your own definite guarantee of maximum cost of sulphur removal in your own plant, under your own conditions is very easily obtained. Just send us a note on your letterhead indicating your interest . . . there's no obligation . . . you can see for yourself what savings you can make.

E. J. LAVINO AND COMPANY
1528 WALNUT ST., PHILA., PA.

RECENT IMPROVEMENTS in the material—such as the new patented disinfecting process that prevents growth of fungus mold—makes possible the unprecedented guarantee offer which applies to all Lavino Activated Oxides.

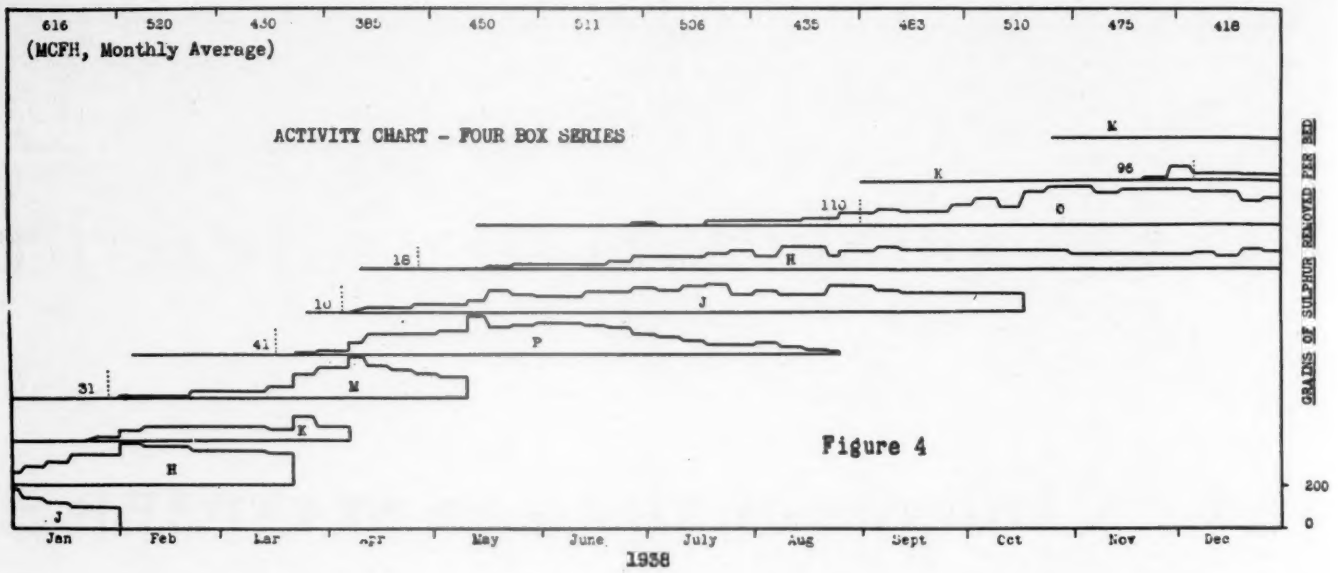

616 520 430 385 450 511 506 435 483 510 475 418
(MCFH, Monthly Average)
ACTIVITY CHART - FOUR BOX SERIES
GRAINS OF SULPHUR REMOVED PER BED
200
0
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec
1938

Figure 4

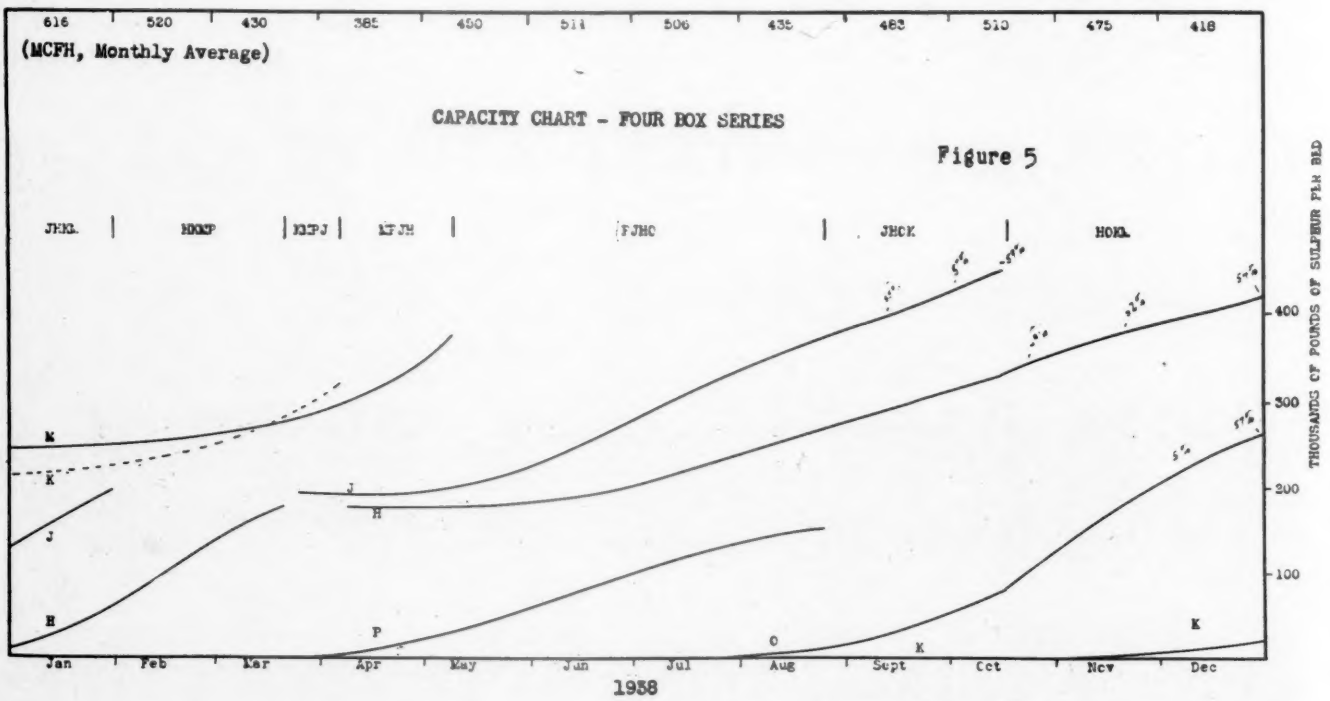

616 520 430 385 450 511 506 435 483 510 475 418
(MCFH, Monthly Average)
CAPACITY CHART - FOUR BOX SERIES
THOUSANDS OF POUNDS OF SULPHUR PER BED
400
300
200
100
Jan Feb Mar Apr May Jun Jul Aug Sept Oct Nov Dec
1938

Figure 5

Since it is sometimes impractical to weigh each bed of oxide a convenient method to use where the material is mixed at the plant is to unload the ore in convenient piles, recording the weight and moisture, mixing with shavings when needed. The weight of the shavings should be recorded when received. Another method is to drop the mixed material down a chute equal in height to the average drop of the oxide in filling, into a cubic foot box. The weight per cubic foot thus obtained can be used to calculate the weight of the material used, knowing the volume of oxide in the box. A sample for moisture content will allow reducing the bed to dry weight.

Probable Cause of Trouble and Remedy

In general very little difficulty will occur in removing H_2S if an active oxide is used and an adequate supply of air is available. However, the universal trouble encountered is unexpected traces of H_2S passing through the system. When this occurs the first thing to do is to increase the % of air until the oxygen content of the gas leaving the last box is 0.8% — 1.0%. The inlet temperature should then be raised to 110° F. + and the rate of gas flow increased if possible. In the course of a few days, improvement should be noticed, if the condition of the oxide in the series is satisfactory. If improvement is doubtful then backward rotation should be tried. Rotating backwards each week, or more often if desired, invariably improves conditions due to some revivification and deposition of moisture, the latter is probably more beneficial.

Poor results generally are due to the oxide drying out.

Moisture is primarily the medium through which sulfiding reactions take place, bringing the H_2S into intimate contact with the hydrate of iron. Excessive amounts of moisture (5) are a detriment due to the high specific heat of water which prevents or delays rise in temperatures, caused by the reaction of H_2S and the hy-

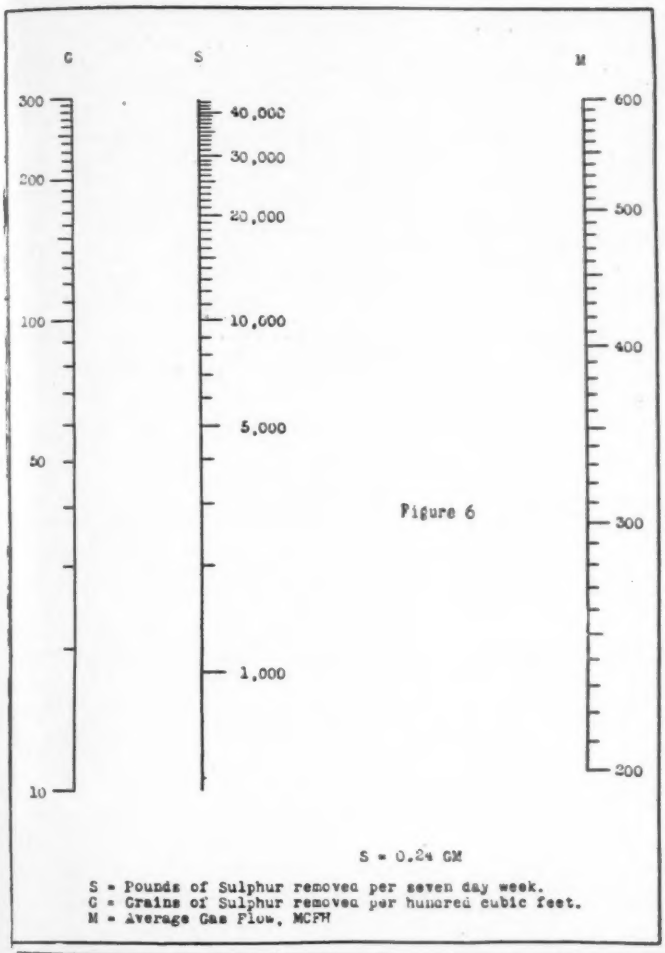


Figure 6

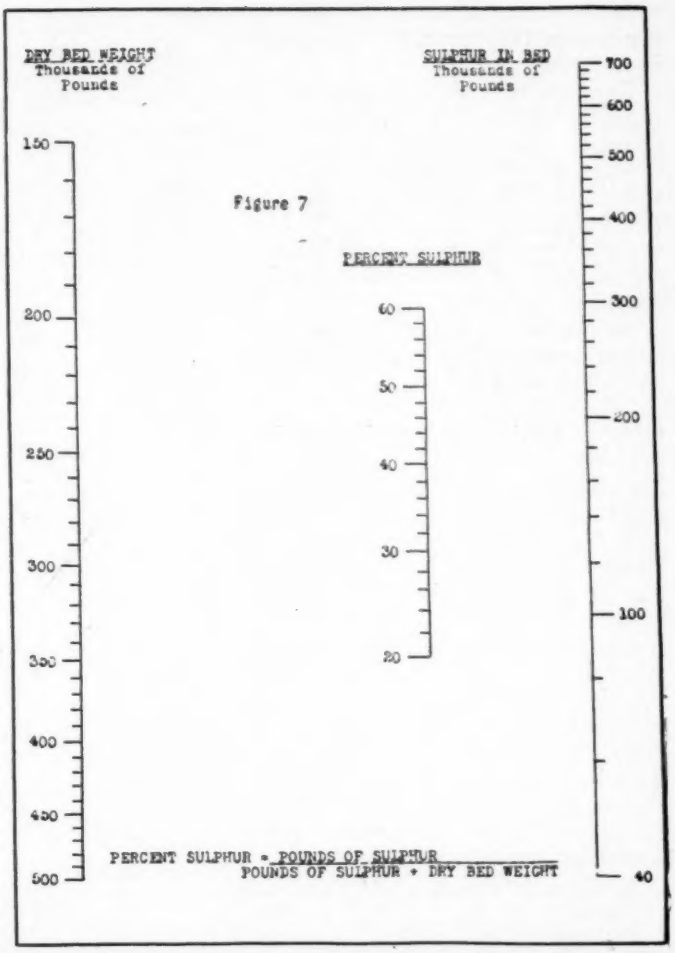


Figure 7

The Complete Purification Service

OUR PURIFICATION ENGINEERS have built into **GPM** Iron Hydroxide twenty years of specialized ingenuity and experience. We have *perfected* a material which is not only impressive in the laboratory, but, more important, has met the practical test of diversified plant use through the years. We have erected a *standard* for purification.

During this period, moreover, we have not only developed an oxide of unerring dependability and economy, but a *complete purification service* as well. From detailed observation of hundreds of plants (and each has its special problems); by working out operating problems with gas men on the spot, we have amassed a body of practical knowledge which is placed at the disposal of GPM users.

Whether it be advice on filling the box, inletting of ammonia, application of lime or suggestions for reuse of fouled material, the facilities of our purification laboratory and the personal services of our specialists are available without obligation. Many plants have been using our fouled oxide analysis service regularly; thus they obtain a running account of sulphur absorption as well as the final accurate picture of cost per pound of sulphur removed.

Thus the shipment of oxide is but the first step of our complete service to the gas company, a service the value of which may be judged by the fact that GPM purifies more gas in the United States than all other oxides combined.

GAS PURIFYING MATERIALS COMPANY INC.

Long Island City, N. Y. & Providence, R. I.

drate of iron. Also retards the continuous revivification by the oxygen in the gas.

The condition of the oxide in the series is an important factor. If too many beds are high in sulfur, particularly in the end boxes, the activity will fall off sharply, due to the fact that inorganic salts, sulfur, cyanides, naphthalene, etc., have crystallized on the surface of the individual oxide particles. It is good practice to have at least one new bed, in the end box, and one second fouling bed in service in each series used.

When consistent trouble with trace removal persists after all known factors have been checked the plant oxide should be replaced with a more active material.

Two and three layer boxes with divided flow often are troublesome due to traces passing through the system. In the case of the three layer type if changed to continuous upward flow through the three layers, by blanking the inlet and outlet shaft, the trouble will cease. In the case of divided flow boxes, where gas enters the middle and leaves at top and bottom, consistent trouble with traces is due to condensation collecting in the bottom layer and bottom of box.

If the box is blanked so that foul gas enters at the top and bottom, leaving from the middle, more efficient removal will result.

Usually divided flow is troublesome due to the resistance of the layers being unequal and no means available to control the flow through the individual layer.

Acidity is often the cause of poor results and is due in most cases to excessive oxygen with attendant formation of sulfates. The addition of 5% hydrated lime to a new bed of oxide has some neutralizing effects and assists trace removal. (10) Insufficient oxygen, which retards revivification, is often the cause of a sulfided bed going afire when dumped. This is due to the highly sulfided material starting to revivify immediately upon contact with the atmosphere; the temperature rises rapidly, igniting the sulfur and other combustible material.

If a system is valved for reverse flow individual boxes showing pressure trouble, due to caking, are relieved by reversing the flow. Additional steam or water is also helpful.

The practice of rotation is best carried out if the series is rotated when the basic test shows a slight trace on the inlet to the last box. The rotation should be backward and operated to prevent equal fouling of the boxes in the series.

Cost

An accurate and fair method to compare the relative value of oxide is to reduce the total cost, including the material and handling, plus all labor applied during its life, to a pound of sulfur. Labor cost of changing boxes is affected by the condition of the oxide, mechanical equipment available, and the size of the box. Since conditions of oxide use do not remain the same, allowance must be made in comparing the cost of sulfur removal at different plants.

On the basis of cost per pound of sulfur removed a range of 0.5—1.0c. is considered good, 1.0—2.0c fair and above 2.0 poor. Sulfur per bushel may be calculated from pounds of sulfur per pound of ore for any given pounds or ore per bushel or oxide mixture, and cost can be calculated from sulfur per bushel for any bushel cost of oxide.

Cost per (M) thousand cubic feet can be obtained, knowing the average H_2S concentration and cost per lb. of sulfur, as follows:

Cost per M = Grains H_2S per 100 cu.ft. $\times$ 0.00143 $\times$ cost/lb. of sulfur

Example:

Avg. H_2S = 275 grains per 100 cu. ft., cost per lb. sulfur 1.0c then, 275 $\times$ 0.00143 $\times$ 1.00 = 0.39c/M

A convenient form for recording Capacity and Cost Data is as follows:

Data Relative to Capacity

Example:

Total Gas Purified, M cu. ft. Year 1930	6,000,000
Avg. H_2S content grs. per 100 cu. ft.	250
Bu. oxide in service	100,000
Bu. oxide completely fouled	80,000
Avg. days service, each fouling	125
Bu. oxide in service per M cu. ft. per day (Avg. flow)	6.1
Bu. oxide in service per M cu. ft. per day (Max. flow)	5.3
Bu. oxide used per M. cu. ft. per day (Avg. flow)	4.9

Conclusion

The keeping of a continuous systematic record for the operation and control of purification is necessary to obtain the lowest cost of sulfur removal.

The use of steam materially improves the efficiency of H_2S removal. It is important to keep a record of the days clean for each box. Incomplete tar removal reduces the efficiency of sulfiding.

Each plant, separately, must decide what method can be used to determine how long a sulfided bed should be kept in service, so that the sulfur content when fouled will give the lowest cost per pound of sulfur removed.

Oxide is an uncertain material, it is variable and inconsistent, and the per cent sulfur it contains is no criterion of its life.

If an oxide possesses high activity it will result in high sulfur absorption and rapid revivification.

Example:

Bed. No.	Kind	Foul	% Sul.	lb. Sul./lb. Ore	Cost/lb. Sul.	% Rem.	Days Clean
A	Shaving	2	58.6	1.65	0.98	25	90

% Removal refers to removal at time of dumping.

Summarize the data for each kind of oxide used for cost comparison.

Figure 8

Batch Record

Bed -
Ore - Kind
Lot Number
Cost / Ton
Weight Used
Wt. / Cu. Ft.
% H2O
% Fe 2 03
% Ca O
Date Made

Carrier
Lot Number
Cost / Ton
Weight Used
Wt. / Cu. Ft.
% H2O

Cost Ore
Cost Carrier
Cost Labor
Lime
Weighing
Total Cost
Wt. / Cu. Ft.
Dry Bed Wt.

Foul	Date In	Date Out	Hr	Days In	Days Clean	% S	lbs Sul Rem	lbs Sul /#Ore	Labor Cost Fill	Dump	Cure Disc	Total	/#S	H2O In	H2O Out	pH In	pH O	% Rem	Flow /Hr

Total Cost
Switching
Credit
Net
Net Cost / lb Sul

Spent Tons Dry
Price / Ton

Total Sul
Avail. Sul
Free Sul
Tar
Organic

Oxide Cost Record

The capacity and efficiency of a purifying system depends upon the volume of oxide as well as its activity and efficiency.

The rigid regulatory requirements make it imperative that this phase of gas plant operation be 100% efficient. The time and expense involved in carrying out the suggestions recommended in this paper have proved to be a profitable investment.

Used Oxide

Determination of the value of a used bed of oxide, according to the formula of W. H. Fulweiler and A. F. Kunberger:

Average cost of purification	= Ac per M cu. ft. of gas
Cost of new oxide	= Bc per bushel
Residual value of old oxide	= Cc per bushel
Cost of removing, revivifying & replacing	= Dc per bushel
Gas already purified by one bushel	= E thousands of cu. ft
Number of times oxide has already been used	= F times
Avg. H_2S content per M cu. ft.	= G pounds
Weight of one bushel of oxide	= H pounds
Per Cent H_2S removed by test	= I Per Cent
Capital charge per M cu. ft.	= Jc per M

Then—

$$A = \frac{(B - C) + (F \times D)}{E} + J$$

But J is a constant (practically for such a problem) that does not affect this calculation, so we may write it:

$$\text{Operating cost} = (A - J) = \frac{(B - C) + (F \times D)}{E}$$

The question then, whether or not it will pay to use a bed again with any given absorption test I, depends upon whether

$$\frac{(B - C) + [(F + I)D]}{E + \frac{H \times I}{G}}$$

is equal to; greater than; or less than the average $(A - J)$.

The value I is obtained by a laboratory test, using the Kunberger apparatus for testing oxides. (1)

Note: Used by permission of Mr. W. H. Fulweiler.

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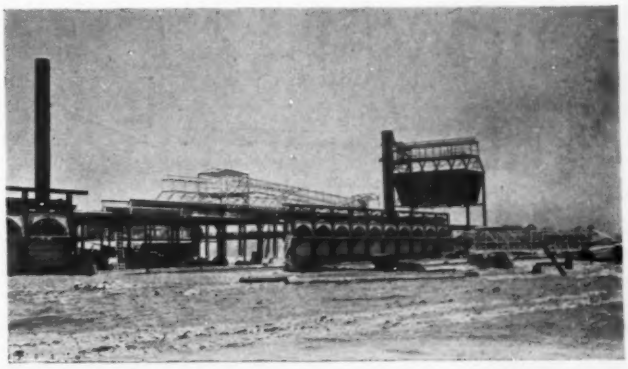
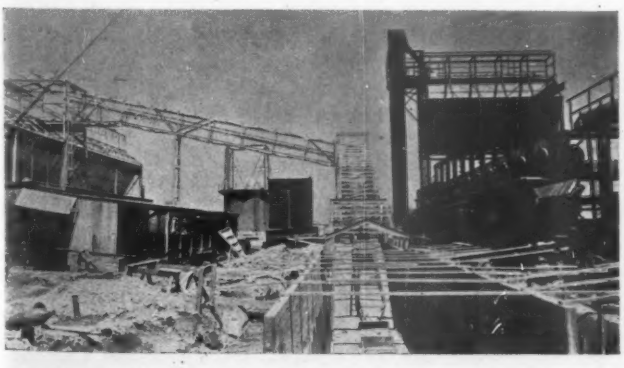


The Midwest Smokeless Fuel Co. Plant near Millstadt, Ill., now nearing completion.



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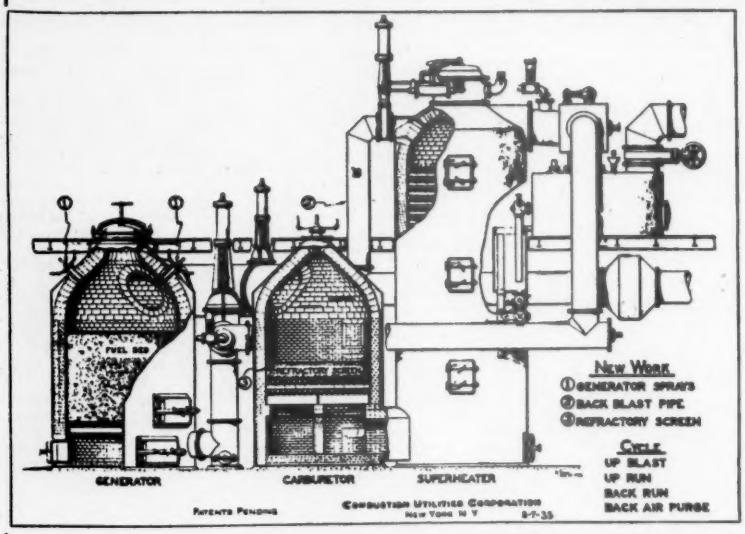

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Tar Handling and Treatment

By
Karl B. Weber
Long Island City, New York
Consolidated Edison Company of New York, Inc.

IT is the purpose of this paper to present a description of the tar handling facilities and an outline of the tar treatment at the Astoria Plant of the Consolidated Edison Company of New York, Inc.

A brief outline of the plant will serve as a background to give some perspective to the material presented.

The Astoria Plant has a nominal capacity of 71,500,000 cubic feet of gas per day. The generating equipment consists of two generator house units of twelve sets each, automatically controlled. The sets are not equipped for back run operation, are without water jackets and automatic grates and are therefore hand clinkered. Twelve sets are of the Williamson single shell and twelve are of the U.G.I. three shell type. There are a total of twelve waste heat boilers producing high pressure steam in conjunction with the main boiler plants. Coke produced at the Hunts Point Plant in Becker type Koppers Coke Ovens is used for generator fuel and various grades of heavy oil used for enrichment.

The equipment for tar handling and treatment falls in the customary classifications; separators, condensers, treatment facilities, dehydration apparatus, fuel tanks, mixing tanks, and storage tanks.

The separators are steel tanks of rectangular design, four in number. Each generator house uses two, one for wash box and the other for condenser tar service. Each separator is 90 feet long, 25 feet wide, and 9 feet in depth and is divided into two compartments. The first compartment, which is 22 feet long, serves as the receiving and tar settling compartment. The second or remainder of the separator receives the overflow from the first and serves as the water compartment for generator house services. The effluents from the wash boxes and condensers are admitted to the tar compartments onto circular plates from below through a hole in their centers. There are no baffles or partitions other than three skimmers across the direction of flow. The water compartments of all four separators are connected together by a 20" diameter header with a valve at each separator. The water compartments are also equipped with steam coils in the bottom and open steam jets, projecting into the water for the necessary heating (Figure I.)

A small, underground concrete tank 25 feet long, 15 feet wide and 7 feet in depth is provided for the collection of the drips of the auxiliary apparatus.

Five suitably connected pumps, one a spare, are used for continuous, separate pumping of each separator and for returning any tar which overflows to the water compartment back to the tar compartment.

Each tar compartment is equipped with an electrical tar level indicator. The apparatus consists of two units, each an electrical circuit which operates a light through suitable switches and relays. The circuit is actuated by the tar making contact with an electrode which projects into the separator a desired distance. The electrode of each unit is set so that the lights operate to indicate a high or low tar level in the compartment.

Tar is pumped continuously from the tar compartments. The tar is kept from overflowing into the water compartments by suitable pumping rates, a tar depth of approximately 5 feet being held. The remaining 3½ feet of depth is sufficient for the overflow of clean water into the water compartment. A material aid to the operator in maintaining the depth of tar are the electrical tar level indicators, which show at all times whether or not the tar is being pumped at the proper rate.

This arrangement of physically separating the tar from the water where the latter is used for generator house purposes, has eliminated the serious drawback of circulating this water from above the tar as in the separator of usual design.

The temperature of the water for generator house use is kept at the maximum obtainable with the use of exhaust steam on the coils and jets in the water compartment. As an additional aid in separating the tar in the condenser effluent, water from this compartment is circulated through the condenser tar drains. When this means of raising the temperature of the effluent has proven insufficient, water is sometimes pumped from the water compartment onto the plate in the tar compartment mixing with the incoming material. Generally, the water content of the wet tar from the separators ranges from 50-80 per cent.

The tar treatment equipment used depends upon the storage capacity required for finished tar. Normally, 3—400,000 gallon steel tanks 50'-0" diameter by 27'-0" high are used; though for extended periods of peak loads two of the steel tanks have sometimes proven sufficient for the requirements of the plant. Two 375,000 gallon rectangular, underground concrete tanks are also available for treatment or storage.

Each of the steel tanks is equipped with three horizontal, spiral heating coils set 18" from the bottom with a heating area of 1.65 sq. ft per gallon of liquid, two heaters of 315 sq. ft. of heating area each, a transfer and circulating pump, two adjustable sprays, a water drain and tar header with valves spaced 2 feet apart. A continuous rotary strainer at the in-

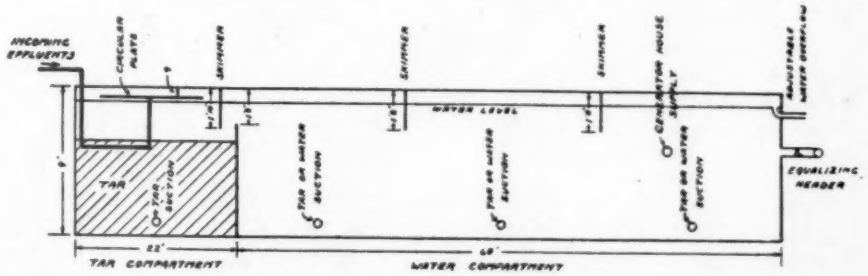


FIG. I CROSS SECTION OF TAR SEPARATOR

Presented at Joint Committee Conference of the Production and Chemical Committees, American Gas Association, Rochester, N. Y., May 22, 24, 1939.

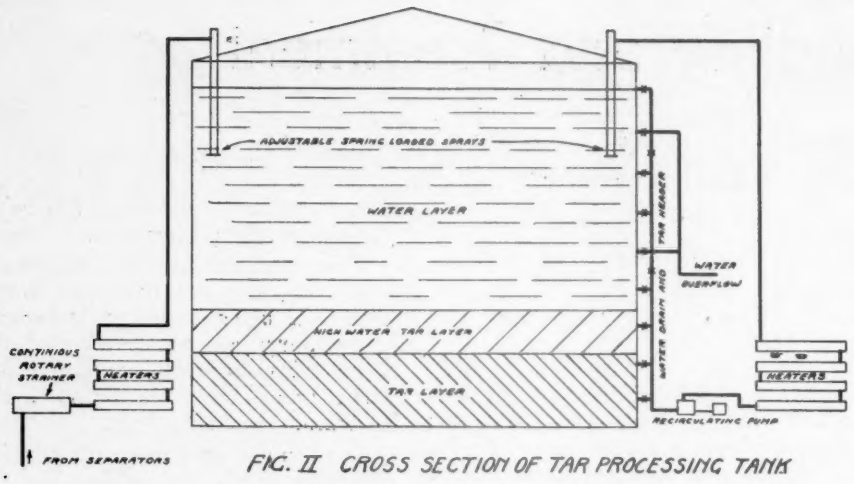


FIG. II CROSS SECTION OF TAR PROCESSING TANK

let of the heaters strains all material coming from the separators. (Fig. II)

The tar treatment procedure of boiling or heating batches in a processing tank for an extended period of time followed by a period of settling, after which the separated water is drawn off is not practiced at the plant.

In the method used, a layer or zone of water above the tar is maintained at all times. The wet tar after heating to 220 to 240° F. is sprayed at a pressure of 20 to 40 pounds in the zone of water above the tar. This zone of water is held at a sufficient height to keep the spray immersed a minimum depth of one foot by controlling the removal of the separated water from the tank by means of the water drain header. The finished tar is pumped from the bottom of the tank, as required. Both the depth of the tar and water zones vary according to separator pumpings and tar and water withdrawals from the tank. The only limit of the height of the tar layer is that it must be kept a foot below the spray, so that at all times, the wet tar is sprayed into the water.

The tar in the tank is further conditioned by reheating and spraying through a second spray. It can be taken from any level desired by use of the aforementioned header.

Additional heat treatment of the tar is accomplished by means of the steam coils in the bottom of the tank.

Segregation of tars is practised at the plant to avoid emulsion conditions and as an aid to processing. One treatment of the wet wash box tar reduces the water content sufficiently for boiler use, an average of 25% water in this tar meeting the demand satisfactorily. In processing this tar, it is worthy of mention that the procedure described has eliminated an exceedingly objectionable characteristic of the method employed previously; i.e., an excessively high viscosity tar. The light oil which previously was boiled off is kept in the tar and burner difficulties and clogging of the air passages of the checker flooring of the boilers have been stopped.

If storage demands permit, the condenser tar is processed twice in the manner described, two tanks being used in series. Being more economical in its steam requirements, two tanks for finished condenser tar are used whenever possible. One processing of the tar however, is usually sufficient to reduce the water content within the capacity of the tar dehydration equipment. The average water content ranges from 10-15 per cent, depending upon load conditions.

The principle of passing wet tar through a layer of water has been utilized in the past to process an accumulation of high water tar in the underground, concrete tanks, which formerly were ammoniacal liquor storage tanks. The high water tar in these tanks was treated by simply pumping the material from the bottom after heating, through orifices, and allowing the material to fall through a layer of water above the wet tar.

The plant has two dehydration units; one a redesigned light oil fractionating still, (Figure III), the other a redesigned ammonia liquor still (Figure IV).

The light oil fractionating still designed for distilling benzol, toluol and xylol from light oil was changed by connecting four spiral-coil high pressure steam heaters to the dephlegmator of the still column and connecting the vapor line to a condenser. A decanter for separating the light oil and water evaporated was provided. The heating coil in still tank was disconnected and vapor tubes of the column were plugged.

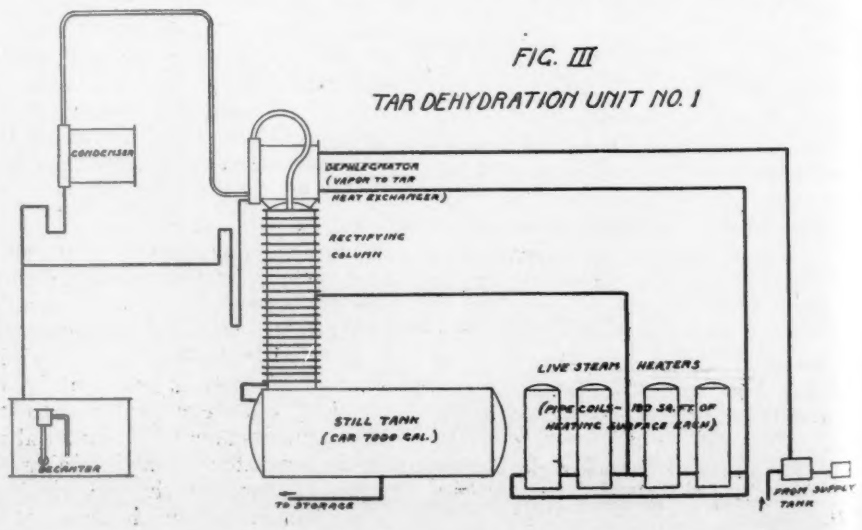
The tar is pumped from a supply tank around the vapor tubes of the dephlegmator which serve as a vapor to tar heat exchanger. The tar then passes through the four heaters arranged in series of two each in parallel and into the tenth section or practically the middle of the still column The tar flows down into the still tank where another pump discharges it to the finished tar tank. The light oil and water are condensed and then separated in the decanter.

The changes to the ammonia liquor still amounted to connecting steam heaters to the column, disconnecting the steam supply into its base and providing the necessary pumps, condenser, and decanter as in the previously described unit. The heaters are in 16 sections, arranged in two parallel banks of 8 sections each. The sections are in series; 5 in a horizontal position followed by three vertical sections. The outlet of each bank is connected into the middle of the still column. Each bank has its individual pump.

Operation is the same as previously mentioned, either or both banks of heaters being used. The process

FIG. III

TAR DEHYDRATION UNIT NO. 1



of dehydration is continuous and as the units can be operated as conditions demand, the heaters of a unit are always run with steam supply at a maximum. An average temperature of the tar entering the column is 260° F. The variable controlling the dehydration is the rate of tar passing through the heaters. This rate is determined by periodic analysis for water content of the tar at the outlet pump. The capacity naturally depends upon the water content of the inlet tar, although on low water content tar, the pumps and condensers have limited the throughput.

These units have processed 1,930,000 gallons of tar during a period of a month from 7% inlet water to 0.4% in the finished tar.

This completes the description of the tar handling facilities and outline of the tar treatment of the plant which serve efficiently and economically to produce for sustained period over 90,000 gallons of finished tar per day. It is believed that the tar treatment process described has effected a substantial saving in steam consumption. Lest an impression be fostered that the design of the separators, their operation or the procedure for tar treatment be the sole cause for the successful outcome of tar handling, too much emphasis cannot be made that the efficacy of tar handling begins with and is highly dependent upon generator house operation.

The maintenance of the proper temperature and the establishment of the correct heat balance in the sets for the particular oil used is the foundation upon which the hopes and desires of the tar operator rest. Smooth, consistent operation of heavy oil tar treatment still is predicated as in the days of gas oil enrichment upon the successful and efficient handling of the oil in the generator house.

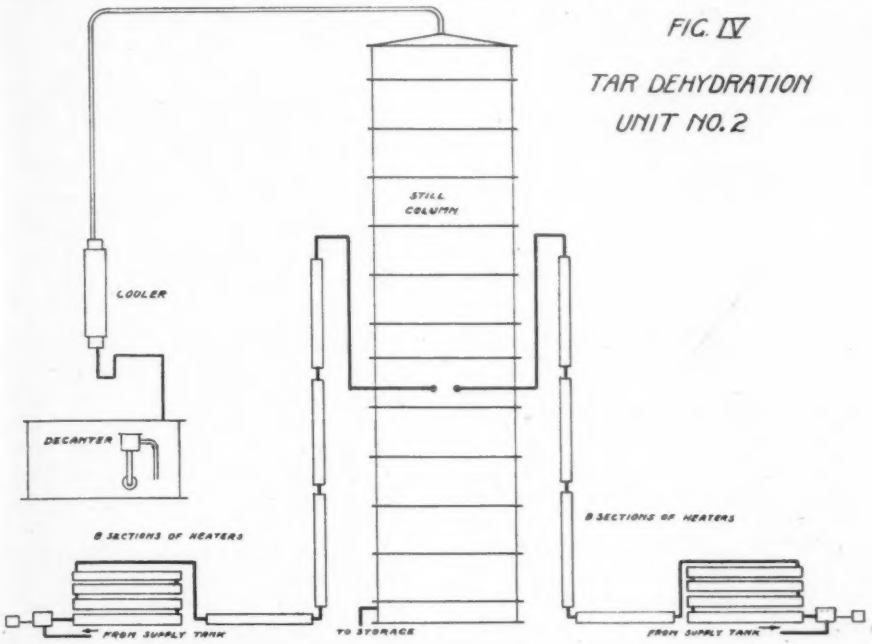


FIG. IV

TAR DEHYDRATION UNIT NO. 2

AGA Holds Production Conference

The Annual Conference of the A.G.A. Production and Chemical Committees was held at the Sagamore Hotel in Rochester, N. Y. on May 22nd, 23rd and 24th, 1939, with an attendance of about 250. Several of the many excellent papers presented at this meeting are reprinted in this issue of the *Journal*.

Monday afternoon was devoted to a series of Round Table Luncheon Conferences at which those attending were given opportunity for a frank off-the-record discussion of "Coal Carbonization and By-Products," "Water Gas Operation" or "How can the Chemist Help the Operating Engineer."

Through the courtesy of the Rochester Gas and Electric Corporation the Tuesday afternoon session was held at the Oak Hill Country Club, where opportunity was later afforded for golf and other recreation and an evening of special entertainment.

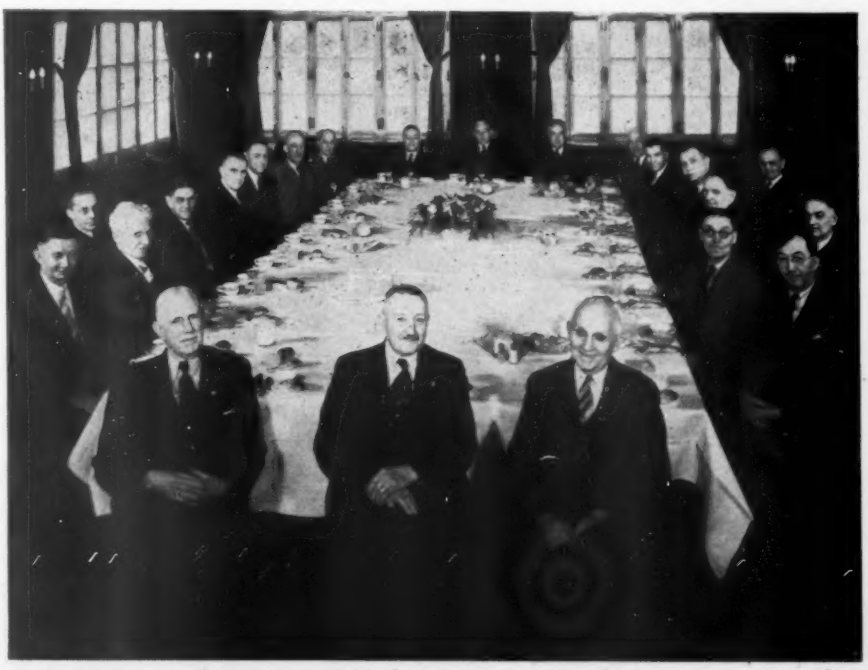
FHA Recognizes Seal

Official recognition of the A.G.A. seal of approval is contained in the new specifications of the Federal Housing Administration covering the installation of gas appliances in housing projects.

The specifications provide that gas appliances must conform to the standards established by the A.G.A. The FHA states that the approval seal of the A.G.A. Testing Laboratories or certification of compliance with the approved standards of the Association shall constitute evidence of compliance.

Fiftieth Anniversary Luncheon For Veteran Meter Maker

A luncheon was given on May 11 at the Penn Lincoln Hotel, Wilkinsburg, Pa., in honor of Oscar Meyer, who rounded out fifty years of continuous service at the Pittsburgh Equitable Meter Company. The guest list included fellow employees and officials of the company whose total service amounted to 665 years, an average of 30 years for the entire group. Three of the group—Oscar Meyer, H. C. Chrisman and Joseph Kline (shown in the foreground of the picture)—have a total service record of 150 years.



Luncheon tendered Oscar Meyer of the Pittsburgh Equitable Meter Co. on May 11th.

Experience With Silicon Carbide Generator Linings At the Boston Consolidated Gas Company

By

James Penney,

Technical Assistant

May 1, 1939

WHEN six 10′ 6″ carburetted water gas sets were installed at the Everett Plant of this company in 1908 and a seventh set the year later, the generators were lined with an inner 9″ key firebrick against a 4½″ circle brick, with one and a half inches of asbestos separating the circle brick from the steel shell. Material cost was $145 and labor cost $140, a total of $285 per lining of 5′ height.

This type of lining was used in continuous operation up to 1929, using both soft coal as well as coke for fuel. (Coke with an ash fusion temperature of approximately 2400°F.) Using these types of fuel no excessive clinker trouble was experienced and hours of service averaged 2400.

About 1929 it became necessary to utilize a different type of coke as fuel—coke with a higher ash fusion temperature — approximately 2700-2800°F. Trouble was immediately experienced with larger amounts of hard hanging clinker which not only increased operating costs but dropped the generator lining service period to 1800 hours. To solve this difficulty two different makes of silicon carbide linings were installed in 1930.

Number three set was lined with a silicon carbide lining* as manufactured by Company A. This lining (9″ thick) was backed by ½″ of clay, 4½″ of firebrick and 1½″ of asbestos. Height was 4′ above grates. At this time arches were not installed—lintels and standard 9″ × 4½″ × 2½″ bricks were used over the doors. This arrangement was not entirely satisfactory—the lintels would melt and the doors become very hot.

To remedy this, silicon carbide arches were installed over each door in 1935. At the same time the silicon carbide lining was raised an additional foot to a total of five feet above the grates.

In April, 1939, it was necessary to replace two of these arches in order to install new door frames and sleeves.

When inspected in April, 1939, after 4767 hours of service the lining had eroded, particularly in the area just above the doors. Wear due to cleaning tools was also evident at edges of arches and at areas to the right of No. 3 and No. 6 doors and to the left of No. 1 and No. 4 doors.

It was estimated that about 8000 hours of service would be obtained before repairs would be required.

In 1930 at the same time as the silicon carbide was installed in No. 3 set, another type of silicon carbide lining* as manufactured by Company B was installed in No. 6 set. This lining was four feet high and consisted of 9″ of silicon carbide, ½″ of clay, 4½″ of firebrick and 1½″ of asbestos. Total material cost was $842. No arches were used—lintels and straight blocks were employed instead.

Results were unsatisfactory, the blocks spalled and the corners of each brick dropped off. The lining was removed in 1936 after 1500 hours of service. Note that these blocks were four inches thick.

Both of these silicon carbide linings installed in 1930, however, gave improved clinker conditions—clinker was much easier to remove and came down to grate more easily.

A year or so later the plant was shut down and when operation was resumed in 1934 it was of an intermittent nature. In 1936 four more linings (Company B) similar to the type used in No. 3 set were installed in sets No. 4, 5, 6, and 7. (One of these replaced the previous unsatisfactory silicon carbide linings in No. 6 set). The new silicon carbide lining was 9″ thick to a height of 2′ 3″ above the grates; above this the thickness was 4½″ for a total lining height of 5′ 4½″. The silicon carbide was backed up by ½″ of clay, 4½″ or 9″ of fireclay and 1½″ of asbestos. Material cost was $1240 while labor charges were $150 per lining. (For construction details see drawing).

These sets have been operated intermittently using a high fusion ash coke, (2700-2800°F.) since the installation of linings. Number seven set when inspected in April, 1939, after 2000 hours of operation showed little evidence of wear. Small areas to the left of doors No. 1 and No. 4 and to the right of doors No. 6 and No. 3 show some wear due to cleaning tools. Lower edges of arches also suffer from the same cause. Directly above doors No. 1 and No. 3 areas approximately 10″ × 20″ show erosion. Cracks appear in all bricks up to 10 courses above lower door level. These are very fine and do not retain clinker or otherwise detract from value of lining. With the few exceptions noted the lining is in excellent condition.

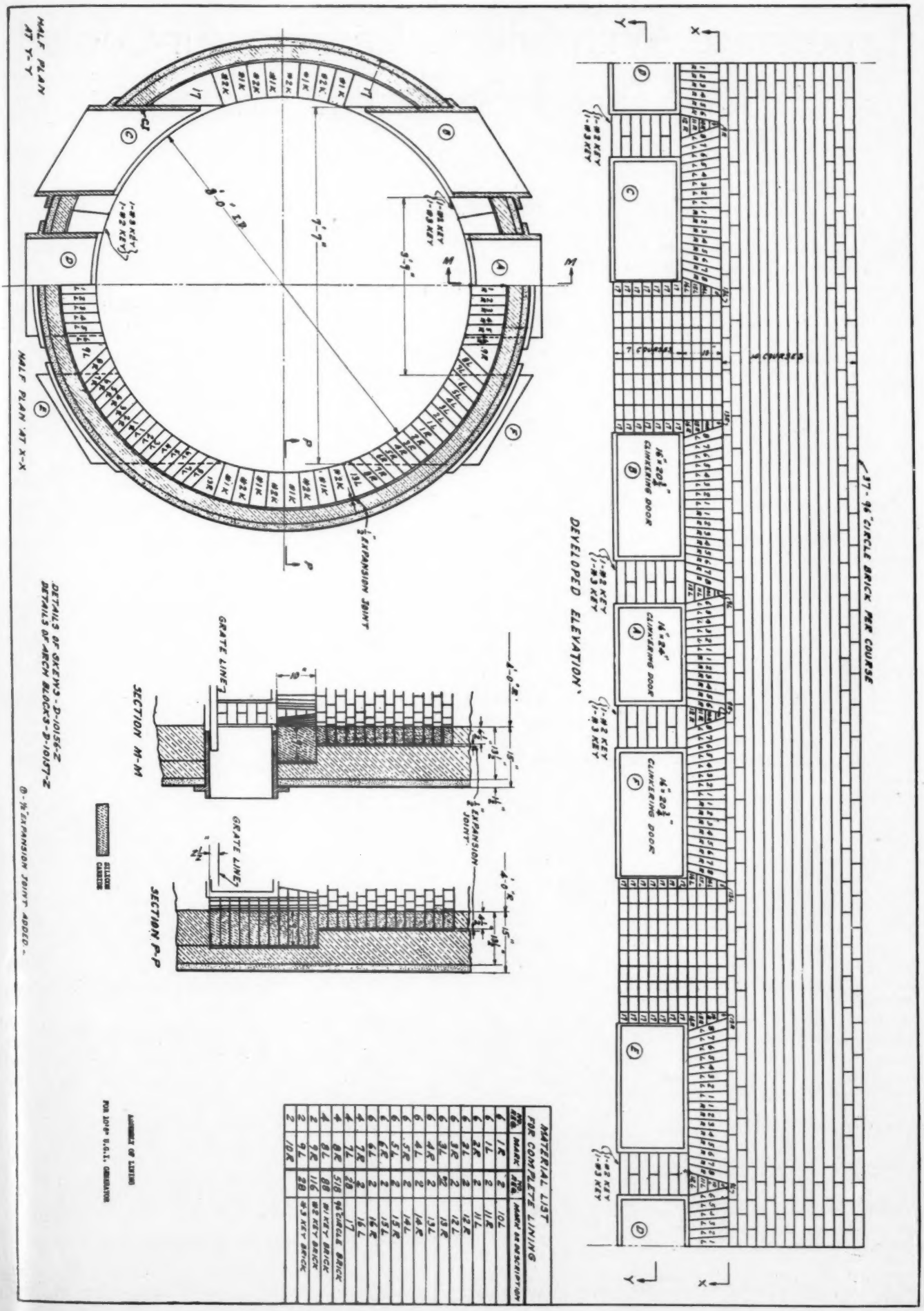
Summary: Two silicon carbide linings were installed in 10′ 6″ sets in 1930—one from Company A and one from Company B. Company B lining failed after 1500 hours of operation. The original Company A and four more from the same manufacturer installed in 1936 are still in service with 4767, 100, 848, 3561 and 2000 hours of service (sets No. 3, 4, 5, 6, 7, resp.) It is estimated that 8000 hours of service each will be obtained before repairs are required. Less hanging clinker and easier removal of side wall clinker have resulted from the use of silicon carbide.

Silicon carbide linings with a material cost of $1240 and installation labor charge of $150 are more economical than firebrick linings with material cost of $145 and labor charge of $140, under our operating conditions, considering the advantages of less hanging clinker, easier removal of same and improved operating conditions resulting therfrom.

Presented at New England Gas Association Meeting, Hartford, Conn., May 12, 1939.

* 560—Silicon carbide blocks with 8 ¾″ outer chord, 7 ¾″ inner chord, 9″ wide, 2″ thick, to form a circle with an inside diameter of 8′.
50—Standard 9″ straight bricks.
50—Standard 1¼″ split bricks.
500-pounds of No. 4 Cement.

* 355—Rotary kiln blocks, 9x96 (9″x7 11/16″x9″x4″)
50—Straight Bricks (9″x4½″x2½″)
50—Split Bricks (9″x4½″x1½″)


HALF PLAN AT X-Y
HALF PLAN AT X-X
EXPANSION JOINT
DEVELOPED ELEVATION
17-9½" CIRCLE BRICK PER COURSE
16'-2½" CLINKERING DOOR
SECTION M-M
SECTION P-P
GRATE LINE
EXPANSION JOINT
SILICON CARBIDE
DETAILS OF SKEWS - D-10156-Z
DETAILS OF ARCH BLOCKS - D-10157-Z
9-½" EXPANSION JOINT ADDED -
MATERIAL LIST
FOR COMPLETE LINING
MARK
NO.
MARK OR INSCRIPTION
9½" KEY BRICK
9½" CIRCLE BRICK
9½" KEY BRICK

Experience With Silicon Carbide Air-Cooled Solid Faced Generator Linings*

By

Herbert C. Jones

New England Power Service Company
Boston, Massachusetts

BEFORE stating our experiences with silicon carbide air-cooled linings, I would like to read the closing paragraph of a report on "The Economics of Carborundum and Clay for Generator Linings," which the speaker presented before the Operating Division of the N.E. G.A. a little over three years ago.

"As far as carborundum is concerned, we are convinced, from our experience, that ventilated-carborundum linings are very satisfactory for use with coke but that solid-carborundum linings are definitely superior for operation with coal. For example, we found that on coal operation certain operating difficulties could not be surmounted until the air ports of the ventilated linings were largely or completely plugged. We believe that most plants now using clay linings can show worthwhile savings with carborundum. Such linings, especially solid linings, must be carefully designed with ample provision for heat insulation inside the steel shell and for expansion of the lining itself. We feel that the development of an air-cooled, solid carborundum lining would present some attractive possibilities, particularly for use with all-coal operation."

You will note that we preferred the solid lining over the perforated air-cooled lining for 100 per cent coal operation, but believed that the development of an air-cooled solid lining had attractive possibilities.

At that time we had installed in a 7 ft. generator, operating on 100 per cent coal, the second silicon carbide solid lining. With these linings in this particular set we experienced difficulties from excessive expansion which resulted in damage to the generator and outer clay lining, and excessive heating of the generator shell.

First Air-Cooled Solid Faced Lining

We were confident, however, that the installation of a silicon carbide air-cooled solid faced lining would result in our gaining the advantages and eliminating the disadvantages of both the perforated and the solid linings, and, therefore, a lining of this type was installed in an 8 ft. generator in December, 1936. The generator fuel consisted of 20 per cent coke and 80 per cent gas coal and the set operated on light gas oil and utilized high pressure (100 to 125 lbs.) steam.

The lining extended six and one-half feet above the grates, and was constructed of Bernitz silicon carbide generator blocks the same as used in a standard Bernitz air-cooled ventilated lining except that all of the blocks were solid faced or non-perforated. The usual ducts required for a Bernitz lining were provided in the fire clay lining to connect the opening in back of the silicon carbide lining with the ash pit.

Air and steam were admitted at the top of the space in back of the silicon carbide lining through six pipes which were connected to a bustle pipe extending around the generator. The bustle pipe was connected, through an hydraulically operated valve, to the main air supply. This valve is interlocked with the generator blast valve so that both valves will be opened or closed at the same time.

The uprun steam line was connected both to the bustle pipe on the generator side of the hydraulically operated valve and to the normal connection into the generator ash pit, each connection being provided with a hand-operated regulating valve.

With these connections, you will readily note that when the generator air valves are opened, air will be admitted into the ash pit through the normal connection, and also into the space in back of the silicon carbide lining through the bustle pipe connections. The quantity of air is regulated by the standard butterfly valve in the connection to the ash pit.

Following the blow period, the air valves are closed and the uprun steam admitted. The quantity of steam admitted to the bustle pipe or the ash pit is controlled by the hand regulating valves. The total steam is controlled by the normal uprun steam regulating valve.

That portion of the generator air and uprun steam which is admitted through the bustle pipe will travel downward in back of the non-perforated silicon carbide lining and be discharged into the ash pit, thereby preheating the air and steam and cooling the silicon carbide lining. Approximately 50 to 70 per cent of the air and 30 to 50 per cent of the uprun steam is admitted through the bustle pipe.

Results of Operation

At 3600 hours of operation it was evident that the lining material was breaking down prematurely. After 6670 hours of operation, sections of the lining had failed and, therefore, a new lining was installed in February, 1939. Inspection of the first lining, before removal, revealed some very interesting information. We found that at the location of maximum cooling the lining was in very good condition while at the locations that received a minimum of cooling the lining was in the poorest condition. A change in type of silicon carbide was made at this time.

We took advantage of this information by installing three additional pipes from the bustle pipe to the back of the lining; a pipe being located over each of the three cleaning doors. This increased the total connections to nine.

The replacement of the Bernitz ventilated lining with the Bernitz air-cooled non-perforated lining has prevented air and steam from by-passing the fuel bed, and has made possible a fuel-oil saving equivalent to slightly less than one pound of fuel per M.c.f. The much greater preheating of air and steam also probably produced some beneficial effect.

Additional Installations

In June, 1938, another silicon carbide air-cooled non-perforated lining

** Presented before New England Gas Association, Operating Division, at Hartford, Conn., May 12, 1939.*

was installed in a 7 ft. generator in a second plant, operating on 100 per cent gas coal, light gas oil and utilizing high pressure (100-125 lbs.) steam.

The lining was constructed in the same manner as the one in the 8 ft. generator except that it extended only 5 ft. above the grates, in place of six and one-half feet, and air and steam were admitted to the lining through twelve pipes, in place of nine pipes as finally arranged in case of the 8 ft. generator. The use of twelve pipes provide one pipe over each of the two cleaning doors and ten pipes around the generator near the top of the silicon carbide lining.

This lining replaced the silicon carbide solid lining which was previously referred to. The lining has operated 3600 hours to date (May 12, 1939) and shows only a slight wear on approximately 25 per cent of the lining, this being at the hottest zone. The temperature of the generator shell, directly above and between the cleaning doors, has been reduced from 500 deg. F. to 150 deg. F., and a fuel-oil saving equivalent to approximately one pound of fuel per M.c.f. is being made. We attribute the savings in part to the preheating of the air and steam and to lower radiation losses as a result of cooler generator shells, but particularly to better packing of the fuel at the side walls which results in providing a more uniformly reactive fuel bed with the minimum of blow holes around the periphery.

Another silicon carbide, air-cooled lining of the same design is on order for installation in the 7 ft. generator of a new water gas set to be erected early this summer in a third plant. Here we now operate a 5 ft. set equipped with super duty clay linings in the generator, using 100 per cent gas coal, light gas oil, and high pressure (100 to 125 lbs.) steam. The new 7 ft. set will operate on the same fuel and oil, but will utilize low pressure steam (15 lbs.) from an accumulator. The new style air-cooled lining will eliminate the building up of side wall clinker, as now being experienced, reduce the clinkering or cleaning time, and result in better operating efficiencies due to much better fire conditions. Continuous operation of the new set is important since the older spare set which is much more costly to operate must be used as little as possible.

In certain types of water gas sets, where heavy oil is used and reforming in the generator is a part of the operating cycle, considerable difficulty is being experienced in obtaining a refractory material, for the generator linings, that will withstand the intense heat, prevent overheating of the generator shell and doors, and operate a sufficient length of time. Where refractories fail after relatively short periods of operation, it often results in the spare, inefficient, sets being operated too much of the time.

In another of our plants where such a condition exists, we lose over $50 a day when operating the spare set. Serious consideration is now being given to the installation of a silicon-carbide air-cooled solid faced lining in this plant.

Clinker Conditions

About a year ago a special test was conducted for a week on the 8 ft. generator equipped with the silicon carbide air-cooled non-perforated lining, previously described, in order to find out about clinker conditions on the side walls when only coke is used as fuel, also if the clinker conditions were favorable to the use of rotary grates. We knew that the clinker from gas coal did not adhere. We purposely eliminated any attempt to soften the coke clinker, with the result that a relatively hard clinker was formed. On one occasion during the test, the entire fuel bed was pulled so that the actual formation of the clinker could be observed. It was found that the ring of clinker, located from 18" to 24" above the grates, was supported primarily by friction and dropped as soon as the circle was broken at one location. This test showed that rotary grates should operate satisfactorily with this lining. I believe there are possibilities in the use of rotary grates, on the larger water gas sets, with this design of lining.

In the installation of a silicon carbide lining, it must be remembered that this material has a very high heat transfer and it is through air cooling that we protect our shells from excessive heat, and our walls from clinker adhesion during the entire life of the lining. The success of any lining depends on the amount of care that is used in making the installation. Silicon carbide is a higher priced material and warrants greater care in its installation than clay refractories. The work requires both skilled and experienced supervision and all of the air-cooled linings that we have installed have been supervised during the entire installation by an engineer of the company supplying the material.

Conclusions

We feel rather certain from our experimentation of the past two and one-quarter years that silicon carbide, air-cooled solid faced linings will result in sufficient operating economies, through elimination of a number of the present difficulties with other refractory linings, to justify continued work in this line of development.

Three of the groups at Production and Chemical Conference of A.G.A. May 22nd to 24th:—W. H. Fulweiler, Wallingford, Pa.; E. M. Bliss, Newark, N. J.: A. M. Beebe, Rochester, N. Y.; W. S. Guitteau, New York, N. Y.; A. Johnson, New York, N. Y.; J. E. Erwin, Asbury Park, N. J.; J. L. Wood, Asbury Park, N. J.; T. H. Clarke, Philadelphia, Pa.; G. E. Seil, Philadelphia, Pa.; R. J. Chambers, Buffalo, N. Y.

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Attending the final session of the convention of the A.G.A.-E.M. were: (left to right) N. T. Sellman, Assistant Vice-President, Consolidated Edison Co., of N. Y.; F. E. Sellman, Vice-president, Servel, Inc., and member of the board of directors of the A.G.A.E.M.; and E. F. Jeffe, Vice-president, Consolidated Edison Co., of N. Y.

The "CP" Gas Range Program is going well as evidenced by the smiles of R. S. Agee, W. E. Derwent and Alan Tappan.

Gas Appliance and Equipment Manufacturers Hold Annual Convention

Nearly 200 executives of manufacturing companies from all parts of the country and Canada began a three-day meeting on May 24 when the Association of Gas Appliance and Equipment Manufacturers opened its annual convention at the Roosevelt Hotel, New York.

The first general session was presided over by F. H. Adams, V. Pres. of the Association, who introduced W. J. Kelly, of the Department of Water Supply, Gas and Electricity of the City of New York, as the first speaker. After welcoming the delegates to the city, he said, "In 1826, 120 gas lamps were installed on Broadway, from the Bowery to Grand Street, replacing 75 oil lamps. Thus started the Great White Way."

Mr. Kelly also told the gas appliance manufacturers that the New York World's Fair, because of its wide use of gas and its dramatization of the fuel might even have started a new era for the industry.

"The World's Fair Corporation has selected gas for heating its buildings and individual concessionaires are using gas on a large scale for cooking, refrigeration, water heating, industrial process work, etc., all of which indicates confidence in your equipment by the business and industrial leaders who aim to cope with the conditions of tomorrow's world. That confidence is a field worth cultivating and guarding, and will provide desirable returns if you maintain the trust reposed in you by rendering services that will meet the acid test of public opinion."

E. R. Guyer, of Chicago, president of the Association, urged the membership to continue and expand advertising and promotional activities during the year, pointing to the outstanding success achieved to-date by the Association in the CP Range, hot water heater, gas refrigerator, and other such special selling projects. Mr. Guyer said:

"To keep gas appliances before the public, sales promotion and advertising must be continued and expanded to insure precipitation into the minds of the consumer so that the words *gas appliance* and *modernity* will become synonymous. Manufacturers of appliances using competitive fuels have long since recognized importance of sales promotion and advertising. It is about time that we started to compete on an equal basis or at least a basis that we can afford and I think all will agree that we can afford more than we are doing now."

Mr. Guyer also stressed the need for a sustained public relations' research and statistical program for the industry.

C. W. Berghorn, managing director of the Association, told the delegates that 1939 has been a packed year of activity for the membership because of the half dozen promotional campaigns now in progress countrywide as well as the general participation by the organization with large exhibits at the San Francisco and New York expositions.

Mr. Berghorn reported that the Association now has a membership of 350 manufacturers of gas appliances, accessories, and equipment,

The final session of this year's convention was held at the Gas Industries Building at the World's Fair. Luncheon followed in the garden of the "Court of Flame" Restaurant. In the above group are (left to right): Alan Tappan, vice-president of the Tappan Stove Co.; John W. West, Jr., secretary of the Commercial Section of the American Gas Association; Jessie McQueen, home service counsellor for the A.G.A.; H. N. Ramsey, president of the Welsbach Company; and E. R. Guyer, president of the A.G.A.E.M.

from all parts of the country, all of whom are co-operating extensively to enlarge sales throughout the country through use of advertising and promotion.

Following the general opening session divisional meetings were held by the Domestic Gas Range Division, W. E. Derwent, chairman, Rockford, Ill.; Gas Water Heater Division, A. P. Brill, chairman, Pittsburgh, Pa.; Gas Meter and Regulator Division, W. F. Rockwell, chairman, Pittsburgh, Pa.; Gas House Heating and Air Conditioning Equipment Division, H. P. Mueller, chairman, Milwaukee, Wis.; Hotel, Restaurant and Commercial Gas Equipment Division, S. E. Little, chairman, Cleveland, Ohio.

R. S. Agee, sales promotion manager of the Domestic Gas Range Division of the Association, spoke on "Opening Our Eyes and Closing Our Sales."

E. R. Guyer, President of the association, presided at the general sessions meeting on Thursday morning. The first speaker was Senator H. Styles Bridges of New Hampshire. The Senator said that individual initiative in industry has been "drugged into a coma by governmental policies."

He emphasized the need for a "national breathing spell" if the people are not to "fall a prey to the selfish and fanatic." The following seven obstacles in the road to recovery, were cited by him:

1. **War scare or jeopardy of peace.**
2. **The spending by government and increase in debt.**
3. **Danger of inflation as illustrated by the "Thomas Inflation Amendment" now on the statute books which authorizes the President at any time to issue up to three billion dollars in greenbacks.**
4. **The penalizing and inequitable taxes.**
5. **The attitude of the NLRB. The Senator recommended an amendment of the Wagner Labor Relations Act along the lines now advocated by Senator Walsh of Massachusetts and Senator Burke of Nebraska.**
6. **The need of the return of the control of relief to state and local sub-divisions to be administered by non-partisan boards.**
7. **Government competition with business. He said government must be taken out of the field of business.**

"If we correct these things, or at least start on them we will see a noticeable recovery in business," he contended.

George E. Frazer, counsel of the association, named more than eight specific legislative acts enforced by about as many governmental agencies which tie the hands of manufacturers in their production of appliances.

Continuing, the speaker stated: "The manufacturer is essential to the gas industry. Without improved appliances the volume of gas sold will suffer in competition with other fuels. We need bigger, and better and richer manufacturers. Under the burden of regulation it is not improbable that we may have fewer and smaller and poorer manufacturers."

The third day's meeting was held at the theatre of the Gas Industries Building, N. Y. World's Fair Grounds, and was presided over by Lucian L. Kahn, Chairman of the A. G. A. E. M. Program Committee. The first speaker was H. H. Cuthrell, Pres., Gas Exhibits Inc. He asked for unity and national action as an industry.

Mr. Cuthrell declared that in order to achieve such unity "we will have to rid our minds of narrow and somewhat selfish concepts."

He urged the delegates to capitalize on the "asset" which the gas exhibit at the Fair represents by national, united efforts, to compare it with the exhibits of other industries as a preparation for developing a constant, effective program for proving to America that we have equipment and fuel that provides superior service in the World of Today and Tomorrow. We must learn that working together we have that service in our gas appliances and fuel. We have made a fine start by uniting to present an exhibit to the public here at the Fair."

Following the closing general session on Friday, a luncheon for delegates, wives and other guests was held in the "Court of Flame" restaurant.

Pipeline Operation

(Continued from page 27)

which peak shaving can be carried to approximate this ideal condition. Therefore, in a further effort to accomplish this ideal and against the time when firm gas peak demands may involve a "capacity factor" more in excess of 100% than can be conveniently made up from line storage, we are exploring certain possibilities of increasing the system delivery capacity. Among the schemes being considered are:

1. The use of butane as engine fuel in the main line compressor stations on peak days. If proven practical, this would release substantial volumes of gas for sale, dependent of course on the system's installed compressor horse power.

2. The installation of intermediate low compression-ratio booster stations in some of the intervals between main line compressor stations, probably located at relatively short distances down-stream from main line stations.

3. The possibility of increasing transmission pressures somewhat above the original system design.

4. Complete dehydration of all gas on the suction side of our first compressor station.

5. The construction of storage at strategic points in the form of gas holders, pipe fields or by re-pressuring exhausted gas fields.

Storage Considerations

Utilization of an exhausted gas field for storage offers one of the best solutions of this problem but unfortunately an old field adaptable to this purpose is rarely available. While this portion of my paper has been devoted to a general discussion of ideas which might be useful in obtaining the ideal 100% load factor, I will revert again to the Southern Natural Gas Company system. Our system, like most others, does not have an old gas field available for re-pressuring; consequently we have speculated on the possibilities of creating an artificial storage field.

While the idea is somewhat novel, we have directed some thinking toward creating a large cave in the unusual dense granite formation underlying the vicinity of Stone Mountain, near Atlanta, Georgia. A cavern 1,000 feet long by 100 feet wide by 60 feet high, mined out of the rock at a depth of 900 to 1,000 feet below the rock surface, would under certain conditions of design hold approximately 300,000 MCF at 800 pounds pressure. From a system operating point of view no more strategic location could be devised (refer to map) particularly as the quantity so stored would be equivalent to about a week's supply of gas for Atlanta during cold weather. Storage of this magnitude located in this position at the eastern terminal of our main line would in effect substantially increase our system delivery capacity. Without having made a serious estimate, a rough calculation shows the cost of this project as being between $1,500,000 and $2,000,000, which is definitely much less than the equivalent storage and increase in line capacity could be obtained for, through any other means.

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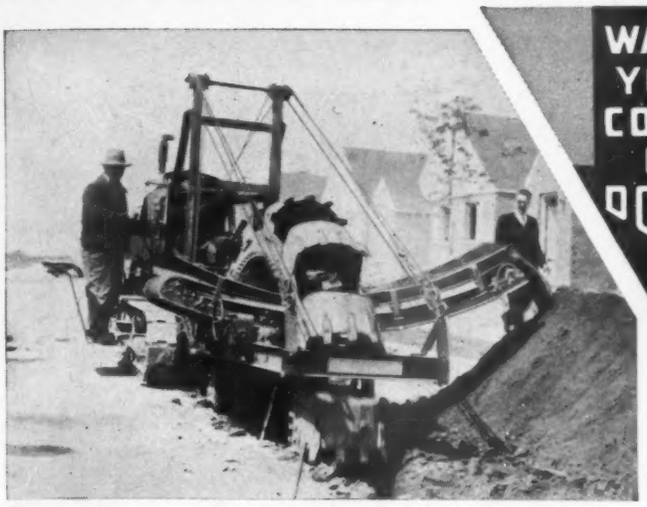

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AMERICAN GAS JOURNAL

53 Park Place New York

News of the Industry

The Pennsylvania Gas Association Holds 31st Annual Convention

The 31st annual convention of the Pennsylvania Gas Assn., was held at Skytop, Pa., May 2, 3, 4, 1939. The session began Tuesday evening with the annual banquet. President E. E. Mench, manager, Penna. Power & Light Co., Williamsport, Pa., in the course of his remarks said:

"The gas industry has been referred to as a "Century-Old Infant", which I think aptly describes the business. Where gas had only a few applications 30 years ago, it now has over a thousand different uses. Our business is a serious one; it is a great business to be in, and one that carries romance, enthusiasm and sincerity. Competition is and has been keen, sometimes fierce, but we can rejoice in the fact that our opportunities are almost unlimited. For an eight-year period ending with 1937, the sale and use of gas was on a decline; however, this might be said of almost any business. Then in 1938, there was a turning point, and the industry again pointed upward. Last year, the sales of manufactured gas for domestic use, other than house-heating, such as cooking, refrigeration, water heating, etc., increased 1.5 per cent for the year.

"The upward trend, this steady but gradual increase in gas use we have seen these past 15 months, did not come about merely by wishing. For the most part, it is the result of a carefully planned program several years in the making, which included advertising for today and tomorrow. The long term national advertising campaign of the American Gas Association along with the local gas companies promotional newspaper advertising has 'put us on the map' so to speak. It has lifted gas service out of the taken-for-granted class. It is showing that gas is an up-to-the-minute service, and that the use of it to enhance the comfort, convenience, and satisfaction of daily home life has been made as modern and effective as the latest model radio set or motor car. We should continue even more so than today aggressive promotion and adequate advertising in our budgets of tomorrow."

"The reduction of the pressure in high pressure transmission mains to a suitable utilization pressure in the distribution system, has always been a problem of major importance to the gas distribution engineer. This is particularly true for companies serving a suburban area. The typical suburban company serves a group of widely scattered communities through a system of high pressure transmission mains radiating from one or more production plants. The communities served may range from highly centralized industrial towns to rambling, strictly residential centers.

"The most practical method of serving low pressure gas to approximately two-thirds of our customers is by means of pounds-to-inches regulator stations, of which there are 150 now in use."

Robert T. Jones, Pennsylvania Power & Light Company, Allentown, presented a paper on "Carrying the Company to the Customer." He said in part:

"Several utility companies have already taken the steps toward personalizing their relations with customers through what is known as the District Representative Plan. This plan is based on concentrating in one man all the services rendered and contacts formerly made by many different employees, such as meter reading, bill delivery, collections, appliance servicing and appliance sales. The District Representative resides in the territory which he serves, is responsible for service to a limited number of customers and, as a result of his frequent calls on customers, becomes personally acquainted with each customer."

The evening session Wednesday was addressed by Conrad N. Lauer, President, American Gas Assn., who said:

"A significant and gratifying development in the gas industry is the reversal of the downward trend in the sale of gas for domestic uses other than house heating The average annual gas consumption per residential customer, exclusive of house heating, fell off 20 per cent between 1930 and 1937. But the data for 1938 show that this trend is now reversed, inasmuch as last year the sales per customer were 1½ per cent greater than they were in 1937. Furthermore, the American Gas Association figures state that 'for the first three months of 1939 the gas companies reporting their sendout to the American Gas Association show a gain of 3.52 per cent over the first quarter of 1938.'

R. A. Maloney, Bridgeport (Conn.) Gas Light Company, in his paper on "What Our Competition Must Meet Tomorrow," said:

"There are several trends visible in the gas industry today that can be used as a basis for accurate predictions. First, the industry has been mobilized nationally. Within the last five years dozens of cooperative national projects have been launched from national and local advertising to the establishment of a new Home Appliance Bureau. It has been recognized by the industry that people are influenced nationally though they buy locally. There is a strong sentiment in the industry toward appliances with improved performance."

Leon B. Eichengreen, vice-president, Philadelphia Electric Company, was elected president of the Association for 1939-40. The honor came to him on his birthday. Other officials elected were: first vice-president, M. A. Boylan; second vice-president, P. T. Dashiell; third vice-president, F. W. Lesley; secretary, William Naile; treasurer, W G. Sterrett. Newly elected members of Council elected were E. E. Linburg, C. K. Steinmetz, F W. Bender, J. J. Moffatt and W. J. Ryan.

LEON B. EICHENGREEN

Geo. Owens Elected Asst. Vice President

George F. B. Owens was elected an Assistant Vice President of the Brooklyn Union Gas Co., Brooklyn, N. Y., on Thursday, April 27. At the same time the company announced several other changes in personnel.

Walter E. Bolte has become Manager of the New Business Department. Frank B. Herty is Manager of the Industrial and Commercial Divisions. Willard C. Wolff has been appointed Domestic Sales Manager. Leonard F. Genz is Supervisor of Wholesale Sales. Gebhard C. Beck has become Gas Utilization Engineer.

Mr. Owens attended the U. S. Naval Academy and Massachusetts Institute of Technology, receiving his Master of Science degree in Electrical Engineering from the latter institution in 1922. He served with the General Electric Company and the Boston Consolidated Gas Company. He resigned his post as assistant superintendent of the water gas plant of the Boston utility to enter this company on July 15, 1930, as Senior Industrial Engineer. In February, 1931, he became Domestic Sales Manager, serving in that post until July, 1936, when he was appointed Acting Manager of the New Business Department. He became Manager in May, 1937.

Inspecting the display of counter appliances, left to right:—F. C. Nuels, The Brooklyn Union Gas Co.; J. F. Pitman, James C. Pitman & Sons, Inc.; Ralph T. Manier, Central New York Power Corp. and T. W. Halloran, New York Power & Light Corp.

During luncheon on the 22nd, left to right:—Hugh H. Cuthrell, Vice President, The Brooklyn Union Gas Co.; Franklin T. Rainey, Vice Chairman, Industrial Gas Section, A. G. A.; Clifford E. Paige, President, The Brooklyn Union Gas Co. and Frank H. Trembly, Jr., Chairman, Industrial Gas Section.

Hotel, Restaurant & Commercial Gas Sales Meeting

The hotel, restaurant and commercial sales branch of the gas industry went in for some real result-producing self-diagnosis on Monday and Tuesday, May 22 and 23, when 200 members of the Industrial Gas Section of the A.G.A. convened at the Hotel St. George, Brooklyn, N. Y., for the 1939 Conference. The schedule of subjects covered included: commercial refrigeration, salesmen's time, modern sales approaches, the executive's angle, controls, chances in the beauty parlor field, 180-degree water, gas heating for Main Street, capitalizing on the World's Fair usage of gas, small and medium size bakers as a market, and sterilization in public eating places.

Frank B. Herty, The Brooklyn Union Gas Company, presided over the Monday afternoon session, while Frank H. Trembly, Jr., Chairman, A. G. A. Industrial Gas Section, led the Monday morning and Tuesday afternoon meetings. Franklin T. Rainey, Vice Chairman, A. G. A. Industrial Gas Section, captained the Tuesday morning session.

In conjunction with the Conference and located in the entrance and registration hall adjacent to the St. George Roof, was set up an 18-unit exhibit of the latest models of gas-fired counter appliances manufactured by 10 different companies. Included was: a six-unit Silex coffee range with improved thermostatically controlled water heater and storage tank; a Pitco Frialator of modernized design and more efficient firing; Vulcan deep-fat fryers, oyster stewers, hot plates, and grilles; a 4-bowl, 2-tray Thermaduke dry steam table; Savory toasters and short-order broilers; the latest Magic Chef griddles and counter ranges; the versatile Star Broil-O-Grill and counter fryer; glass-lined Amcoin coffee urns; the Welsbach Hotzone broiler-griddle; and a modern gas-fired Hydro-Therm sterilizer.

Roy P. Wilson, The Philadelphia Gas Works Company, leading off with advice won through experience on "Penetrating the Commercial Refrigeration Field," admonished that "in general you can't sell a commercial gas refrigeration unit alone—it must be sold in conjunction with the other elements for the customer's refrigerating system."

After describing the differences between the new Servel units and the familiar domestic boxes, and after enumerating many of the most promising fields for commercial gas refrigeration sales, Mr. Wilson dwelt upon the special techniques required in selling commercial refrigeration.

Critical analysis of one's daily habits and plans in developing new non-residential gas customers was strongly urged by Harry A Sutton, Public Service Electric & Gas Co., Newark, who offered a proven system for "Making the Most of Salesmen's Time." Careful and exhaustive market surveys before attacking any group of prospects is most essential. Equally essential is the keeping of accurate data files on each establishment called upon. A form for a "time check sheet" to be used in determining personal sales efficiency was suggested.

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CEDAR RAPIDS, IOWA

Encouragement was the fare dispensed by Clifford E. Paige, President, The Brooklyn Union Gas Company, who delivered the feature address before the Monday luncheon. "The gas industry has turned the corner since 1937," said he, "and average consumptions per meter per year are beginning to show definite improvement. Prospects in the gas business were never so bright as at the present time."

Mr. Paige pointed out that it was significant that what we have accomplished we have accomplished in the face of difficulty, and that, thanks to competition, we are no longer smug and complacent but have become an aggressive and growing industry.

At the afternoon session W. D. Crouch, Robertshaw Thermostat Company, talked on "The Expanding Market for Controls on Commercial Gas Equipment." An indication of the growing importance of controls was offered through the sales record of his company which, since 1932, has achieved an increase in the number of appliance manufacturers specifying his company's control from 22 to 175.

Following Mr. Crouch, Arthur M. Apmann, Derby (Conn.) Gas & Electric Company, led a symposium on the place of gas in the beauty parlor, patterned after the popular "Information Please" radio program. Mr. Apmann presented a vest-pocket survey of the use of gas in the 80 beauty shops in his community of 40,000 population.

"180° Water *Can* Be Sold," said W. S. Walker, Consolidated Edison Company of New York, Inc., in winding up the Monday sessions. "Here's a market in which we can't complain of saturation or competition—let's go after it! Recent improvements in water heaters, and new types of appliances, provide us with powerful new tools to the extent that we can offer customers smaller gas bills and provide a new flexibility of service."

On Tuesday, Arnold E. Schwarz, The Bryant Heater Company, emphasized that in "Selling Gas Heating to Main Street," one must realize that Main Street is "all over town." The market for gas heating is tremendous, particularly in view of "a growing appreciation among merchants of the profit-making possibilities in utility service."

It is safe to say that every man at the Brooklyn Conference was amazed at the extent to which gas is used (almost to the complete exclusion of other fuels) throughout the New York World's Fair, described by Hugh H. Cuthrell, Vice President, The Brooklyn Union Gas Company. More important, however, was Mr. Cuthrell's demonstration of the manner in which this World's Fair usage of gas can be applied by every salesman of non-residential gas in the country.

Appropriately to wind up the conference by taking a look into the future of commercial gas sales, R. J. Rutherford, Vice President, Worcester (Mass.) Gas Light Company, stated, "Probably the greatest fallacy in our industry thought is that we have only four market classifications—domestic, house heating, commercial and industrial. Actually, there are hundreds of classes of users, and each should be considered as a separate entity." The belief was also expressed by Mr. Rutherford that, in the future, commercial gas utilization will see more and more appliances specialized as to function.

All Warm Air Furnaces Required to Display Type Marking

A number of instances have been recently encountered where approved warm air furnaces of the gravity type have been installed in conjunction with separate blowers, the assembly thus constituting what is in effect a forced air system. In such instances the presence of the Seal of Approval naturally has created the impression that the entire assembly had been approved as a forced air furnace, whereas, this was actually not the case. This is for the reason that the addition of a blower to a gravity system introduces a number of factors which may affect its operation and additional tests are, therefore, necessary before approval of such a combination can be granted.

In order to meet the existing situation, this question was fully considered by the Approval Requirements Committee and a ruling adopted for application July 1, 1939. This states that all furnaces approved after that date shall bear a permanent marking as to their type. Each gravity furnace is required to be marked "Approved as gravity furnace only," and each blower furnace marked "Approved as blower type furnace only." This marking will definitely indicate the type of unit to which approval has been granted and will serve to avoid future misunderstandings. In addition, it was also decided that all furnaces, irrespective of their date of approval, shall be required to display such markings on and after January 1, 1940.

A. G. A. Laboratory Test and Approval of Floor Furnaces with Extended Ducts

A recent innovation in floor furnace construction relates to the use of extension heads built integrally with the furnace, the combination being sold as a package unit. In certain cases the furnaces are also provided with a collar for the attachment of hot air ducts leading to adjacent rooms or to upper floors. This has naturally introduced a number of problems in the testing and approval of such units, particularly in view of the necessity for properly limiting the allowable air temperature in such ducts.

After careful consideration of this subject by the Approval Requirements Committee at its April 21, 1939, meeting, a policy was adopted to cover the future testing and approval of such equipment. It was decided that in the case of package units, the length of vertical extension heads should be limited to four feet above the top of the casing and that of horizontal extensions to the vertical projection of the casing. It was also felt necessary to make provision that floor furnaces equipped with collars for the attachment of extension ducts must not allow a maximum rise of air temperature of more than 160 degrees above room temperature as measured in a two-foot duct attached thereto as in the method of test specified for gravity warm air furnaces. All other tests are to be applied in the same manner as under the existing floor furnace standards. Assurance will thus be had against excessive rise in temperature which might result in a fire hazard to surrounding structures.

It was also decided that in addition to complying with the above features, a permanent notice as follows—"Caution: This furnace must be installed in accordance with the manufacturer's instructions" must be provided on every such floor furnace.

Roots-Connersville Chicago Office

The Roots-Connersville Blower Corp. has moved its Chicago office from Room 814, 140 South Dearborn Street, to Room 1027, People's Gas Building, 122 So. Michigan Avenue. There has been no change in personnel.

Appalachian Meter School Committee Hold Meeting

A meeting of the Program Committee of the Appalachian Gas Measurement Short Course was recently called at the University of West Virginia in Morgantown, for the purpose of developing plans for this year's meeting. The committee members shown in the accompanying photo are as follows:

Left to right, front row, seated:

Ray Hitchman, Superintendent of Gas Measurement, United Fuel Gas Company, Charleston, W. V.

J. E. Overbeck, Gas Measurement Engineer, Columbia Engineering Corporation, Columbus, Ohio.

J. R. Sproat, Pittsburgh Equitable Meter Company, Pittsburgh, Pennsylvania.

A. M. Hutchison, Superintendent Gas Measurement, Ohio Fuel Gas Company, Columbus, Ohio.

Back row, standing:

C. H. Whitwell, Superintendent Gas Measurement, Equitable Gas Company, Pittsburgh, Pa.

R. O. Borden, American Meter Company, Pittsburgh, Pa.

J. W. Sweeney, Carnegie Natural Gas Company, Mannington, West Virginia.

A. F. Kraus, Superintendent Gas Measurement, Peoples Natural Gas Company, Pittsburgh, Pa.

H. J. Wagner, Gas Engineer, Public Service Commission of West Virginia, Charleston, West Virginia.

W. A. Staab, Professor, School of Mines, West Virginia University, Morgantown, West Virginia.

G. R. Spindler, Director of Extension Courses, West Virginia University, Morgantown, West Virginia.

B. P. Stockwell, Natural Gas Engineer, Public Service Commission of West Virginia, Charleston, W. Va.

As previously announced, the dates for this year's meeting are August 21st, 22nd and 23rd. It is expected that the 1939 school will attract an even larger registration than the 300 present last year when this, the first eastern meeting of its type, was inaugurated.

The Program Committee of the Appalachian Gas Measurement Short Course.

High Records During April in "Man-the-Sales" Campaign

Utilities with the highest number of installations to their credit as the result of sales made during April in the "Man-the-Sales" or "Flying Cloud" gas refrigeration campaign have been announced by R. J. Rutherford, chairman of the American Gas Association Refrigeration Committee.

In Division 1, in its entirety, Consolidated Edison Co., of New York, reported the greatest total of installations; Washington Gas Light Co. had the greatest number of installations per 10,000 meters in the same division; Michigan Consolidated Gas Co., Detroit, reported the greatest increase in installations over April 1938. In Sections A, B and C, respectively, of Division 1, utilities with the greatest total installations for the month were: Philadelphia Gas Works Co.; Washington Gas Light Co.; and the Brooklyn Union Gas Co.

In Division 2, Providence Gas Light Co. was ahead both in total installations and in greatest number of installations per 10,000 meters. Consolidated Gas, Electric Light and Power Co., of Baltimore, stood second in total installations, and New Haven Gas Light Co. was second in the largest number of installations in the 10,000 meters class.

Leading in the 10,000 meters class in Division 3 were: Florida Public Service Co., Orlando, Fla., first; and Metropolitan Edison Co., Easton, Pa., second. Central Illinois Light Co., Springfield, Ill., was first, and Metropolitan Edison Co., second in total installations in Section A of this division. Florida Public Service Co., was first, and Alexandria Gas Co., second, also in greatest total installations in Section B.

In Division 4, Ohio Fuel Gas Co., of Columbus, was first, and Michigan Consolidated Gas Co., Grand Rapids, Mich., second in greatest total installations. Central States Power and Light Corp., Tulsa, Okla., was first, and Gas Service Co., Wichita, Kansas, second in 10,000 meters class.

In Division 5, Macon Gas Co., was first, and Natural Gas Company of West Virginia, Alliance, Ohio, second, in greatest total installations. Ohio Fuel Gas Co., (Coshocton Branch), Cambridge, Ohio, was first, and Macon Gas Co., second, in the 10,000 meters class.

In Division 6 Virginia Gas Distribution Corp., Staunton, Va.; Kentucky Natural Gas Corp., Owensboro, Ky.; Virginia Gas Distribution Corp., Lexington, Va., and Ohio Fuel Gas Co. (Dresden Branch) Cambridge, Ohio, stood respectively, first, second, third and fourth in greatest total installations.

CP Range Club

The CP Range Club of the A.G.A. recently issued its first number of the "CP Range News." Admission to the Club is open to all dealer and gas company salesmen who sell 25 CP ranges during 1939. Applications now exceed 8,000. A "Ranges" lapel pin, certificate of admission, and membership card will be issued to the successful candidates.

Thomas N. McCarter, Elected Chairman—E. W. Wakelee, Prest. Public Service Co. of N. J.

In compliance with his request at the March meeting that he be relieved of the presidency, the board of directors of Public Service Corporation of New Jersey, at their annual meeting, April 18, elected Thomas N. McCarter, chairman of the board. Edmund W. Wakelee was

Thomas N. McCarter

elected president, and Percy S. Young, chairman of the executive committee, an office created at the suggestion of Mr. McCarter. Mr. McCarter, who has been president of Public Service for the thirty-six years of its existence, will remain the senior executive officer of the Corporation with plenary powers of supervision and direction.

Messrs. McCarter, Wakelee and Young were also elected to similar positions by the Boards of Public Service Electric and Gas Company, Public Service Coordinated Transport and other Public Service underlying companies, at the annual organization meetings of these companies.

The boards of directors of the Corporation and of the underlying companies also elected Thomas N. McCarter, Jr., vice-president in charge of Southern Division, and Robert A. Zachary, a vice-president. Mr. McCarter, Jr., has been assistant to General Edward C. Rose, who remains a vice-president with headquarters in Newark. Mr. Zachary has been assistant vice-president in charge of public relations. All other executive officers of the Corporation and subsidiary companies were reappointed. William D. Hartshorne, who has been assistant to President McCarter, will be assistant to the chairman of the board.

Stockholders of the Corporation at their annual meeting, April 17, in Newark, re-elected Messrs. McCarter, Garret A. Hobart, John L. O'Toole and George Barker, directors for three years. At meetings of underlying Public Service companies the same day the following directors were re-elected: Thomas N. McCarter, Percy S. Young, Edmund W. Wakelee, George H. Blake, John L. O'Toole, George Barker, Edward C. Rose, Matthew R. Boylan, John A. Clark, Jacob T. Barron and Henry P. J. Steinmetz.

Northwest Conference P.C.G.A.

President Farrar has set June 22 and 23 in Seattle as the time and place for the Association's annual Northwest Conference. This conference, always one of the best gas meetings of the year, is primarily a convention for gas men in the Northwest. The meeting has, however, become so popular both because of its setting and the intimacy of its discussions that it is always well attended by Californians and people from other states. The program and arrangements are now being prepared by a committee headed by Jas. F. Pollard, President of the Seattle Gas Company.

New Supervisor at Pacific Coast Branch Laboratories

W. H. Vogan, formerly Chief Inspector of the Cleveland Laboratories, became Supervisor of the West Coast Branch on May 1st replacing F. O. Suffron, who had been in charge for the past two years. This change is in line with the policy which has been followed since the establishment of the West Coast Branch in periodically exchanging personnel.

Mr. Vogan was graduated from the

W. H. Vogan

mechanical engineering department of the Tri-State College of Engineering in 1927. He joined the staff of the Testing Laboratories in August, 1928, and has been employed continuously since that time. During this period he took an active part in the extensive mixed gas research program, as well as the investigation of cast iron pipe joints. He was transferred to the Testing Department in 1931. He was appointed Chief Inspector of the Testing Laboratories in February, 1937.

Field Sales Counsellor, A.G.A.E.M.

John E. Bogan, Peoria, Ill., has been appointed field sales counsellor of the Association of Gas Appliance and Equipment Manufacturers' domestic gas range division.

Mr. Bogan, formerly director of sales promotion for the Central Illinois Light Company (Peoria, Ill.), will devote his time exclusively to field activities of the "CP" Gas Range Program being projected nationally by the Association.

JOHN E. BOGAN

He has been associated with the Central Illinois Light Company in various capacities for more than fifteen years, and has had extensive experience in selling and sales management. Because of his knowledge of advertising and dealer coordination he has served on several committees of the Illinois Public Utilities Association. Since last year Mr. Bogan has been actively connected with the "CP" Gas Range Program, having been assistant regional manager for "CP" promotion in Illinois.

Old Employees Accorded Honors

The United Light and Power Service Co., Davenport, Ia., gave a dinner April 27th to employees with 25 years or more of service with its company, the Peoples Light Co., Tri-City Railway Co. and the C. D. & M. Railway Co. There were 83 employees honored at the dinner.

Jack Ainsley who has just retired as superintendent of the gas distribution for the Peoples Light Co., is the oldest employee in point of service, having entered the employ of the company April 6, 1886. He was presented with a gold pin.

Running a close second as the oldest employee, Charles Schellhorn's connection with the company began in September of 1886. He took one of Davenport's first two electric cars up Brady street on its initial run on Aug. 11, 1888. Both were presented with gold pins.

Others receiving gold pins in recognition of 50 years or more of service were Chris Lagoni, former motorman, and John G. Huntoon, vice president of the Tri-City Railway Co. and former general manager of that company.

The program consisted of the presentation of bowling awards and a discussion of future activities of the recreation club by Hick Math, president; presentation of service pins to Manager Littig, Manager Smith and other honored executives and employees of the United Light & Power Service Co. by George Kuhn, purchasing agent of the United Light; presentation of a service pin to Mr. Kuhn by C. A. Nash, vice president in charge of sales promotion of the United Light; presentation of service pins to honored employees of the Peoples Light Co., by Manager Littig; presentation of service pins to honored employees of the C., D. & M. Railway Co. and Tri-City Railway Co. by Manager Smith; brief remarks by Mr. Huntoon and several songs by Grover Vonder Heyde, with Jack Shumate at the piano. C. A. Nash acted as toastmaster.

Otto Dice has taken over most of the duties performed by Mr. Ainsley. His title will be Street Department Superintendent of Gas Distribution.

W. F. O'Brien, Treasurer Consolidated Edison Co.

William Francis O'Brien, assistant treasurer of Consolidated Edison Company, New York, was elected treasurer at a meeting of the executive committee, succeeding John R. Fenniman, who died April 21.

WILLIAM FRANCIS O'BRIEN

Mr. O'Brien was first employed as a clerk in the commercial department of the Standard Gas Light Company in April, 1899. Subsequently he became assistant cashier, purchasing agent, assistant treasurer, treasurer, and vice-president. When Standard Gas Light Company was merged into Consolidated Gas Company, he became an assistant treasurer of the parent company, now Consolidated Edison Company of New York.

CONVENTION CALENDAR

June

9 *Empire State Gas & Electric Assn.* Group Meeting (Gas Operating) Tower Club, Park Central Hotel, New York.

22-23 *Pacific Coast Gas Association,* Northwest Conference, Seattle, Wash. Chairman, James F. Pollard, president of Seattle Gas Co.

29-30 *Michigan Gas Assn.* Annual Convention, Grand Hotel, Mackinac Island, including July 1.

August

22-25 *Home Service Conference and Training Course A.G.A.* Los Angeles, Chapman Park Hotel.

September

4-9 *Pacific Coast Gas Assn.* 46th Annual Convention Fairmont Hotel, San Francisco.

9 *Gas Industry Day,*—Golden Gate Exposition.

October

9 *Gas Industry Day,* — New York World's Fair.

9-12 *American Gas Assn.* Annual Convention, New York, N. Y.

19-20 *Empire State Gas & Electric Assn.* Annual Convention, Westchester Country Club, Westchester, N. Y.

Food For Thought

1. 20,000 miles of mains surveyed.

2. 14,000 new gas leaks located.

3. 40,000 valuable reports made on trees and shrubs.

4. 150 companies using the service.

5. Enough savings in unaccounted for gas to pay the bill.

6. A trial will convince you.

May we hear from you?

New England Forestry Service Inc.

75 Federal St., Boston, Mass.

INDEX TO ADVERTISERS

Alpha Lux Co., The 38
American Lava Corp. ..... —
American Meter Co. 8
American Stove Co. ..... —
Auditorium Hotel ..... —
Autogas Corporation 56

Barber Gas Burner Co., The 56
Bismarck Hotel 59
Blaw-Knox Company 5
Brookmire Corporation ..... —

Carbide & Carbon Chemicals Corp. ..... —
Cast Iron Pipe Research Assn., The 2
Chaplin-Fulton Mfg. Co., The 28
Chelsea Hotel 56
Cleveland Trencher Co. 59
Coal Carbonizing Co. 47
Combustion Utilities Corp. 48
Connelly Iron Sponge & Governor Co. 48
Cooper-Bessemer Corp. ..... —
Cruse-Kemper Co. 30

Dresser Mfg. Co. 21

Gas Purifying Materials Co. 45
General Coal Co. ..... —

Hays Manufacturing Co. 56
Howle Company ..... —

Improved Equipment—Russell Engineering ... 48

Kitson Company 30

Lambert Meter Co., Inc. 28
Lattner Mfg. Co., P. M. 61
Lavino & Co., E. J. 43

Merco-Nordstrom Valve Co. .....Front Cover
Metric Metal Works 8

National Tube Co. ..... —
New England Forestry Service 64

Partlow Corp., The 37
Phillips, Alfred I. ..... —
Pittsburgh Coal Co. ..... —
Pittsburgh Equitable Meter Co. .....Front Cover
Pittsburg Water Heater Corp. ..... —

Research Corp. ..... —
Republic Heaters Sales Co. 56
Reynolds Gas Regulator Co. 28
Robertshaw Thermostat Co. ..... —
Roper Corp., Geo. D. ..... —

Safety Gas Main Stopper Co. ..... —
Semet-Solvay Engineering Corp. 3
Servel Electrolux Div. 6
Skinner Co., M. B. ..... —
Sprague Meter Co., The .....Fourth Cover
Superior Meter Company 33

Titan Valve & Mfg. Co., The 56
Therminsul Corp. ..... —

Union Carbide & Carbon Corp. ..... —
United Engineers & Constructors, Inc. ..... —

Western Precipitation Co. ..... —
West Gas Improvement Co. 48
Worthington Pump and Machinery Corp. 22

Now Available—Gas Meter Repair Man

Twenty years' experience repairing gas meters. Prefer eastern location. Excellent references. Address Box 110, c/o American Gas Journal, 53 Park Place, New York City.

Position Wanted—Gas Meter Repairer

I would like a position as a gas meter repairer or supervising a gas plant that wishes to repair its own gas meters. I am thirty-three years of age. I have had sixteen years of experience in the following: Gas meter repairer, gassing, and proving gas meters. I can obtain any references regarding my previous employment. Address Box 109, c/o American Gas Journal, 53 Park Place, New York City.

Advertising Display to be Feature of Industrial Advertisers' Conference

The best in current industrial advertising will be on display during the 1939 Conference of the National Industrial Advertisers Association, which will be held at the Hotel New Yorker, New York City, next September.

Plans for the exhibit are announced by Robert L. Ware, of the Western Electric Company and Chairman of the N. I. A. A. 1939 Conference Advertising Exhibit Committee.

All of the 1300 members of the National Industrial Advertisers Association will be invited to participate. Entries, mounted on standard panels, will be installed in the exhibit space in the order in which they are received, so that small advertisers will have the same chances of good display and attention as large ones. No exhibitor can submit more than six panels, and each panel should, if possible, be devoted to a single complete campaign.

Awards will be given for the twenty best panels as selected by a jury composed of professional advertising men and industrial executives, and at least one panel in each of the six N.I.A.A. classifications of industrial advertising will receive an award. The Committee plans to provide the jury with a criterion, or advertising "yardstick," to assist in making equable decisions and to insure full consideration of the technical excellence of all exhibits.

In addition to the official jury, the "Copy Chasers," well-known critics of industrial advertising, will make an independent inspection of the display and report their opinion of the various exhibits. This report will in no way influence the giving of awards but forms an additional attraction, presented for comparative and educational reasons.

Each award carries two prizes—a certificate will be presented at the Conference (if possible) to the advertising man responsible for the advertising, and a bronze plaque, mounted on a polished oak base, will be sent by the President of the N. I. A. A. to the President of the company isuing the advertising.

Obituary

W. P. HUTCHINSON

William P. Hutchinson, president and general manager of the Sprague Meter company, died on May 21st at Bridgeport hospital where he had been a patient since May 8.

An employe of the Sprague company since 1910, Mr. Hutchinson became vice president of the company after serving a few years as a salesman.

When Henry H. Sprague, inventor of the Sprague meter, retired as president of the company, Mr. Hutchinson became president and retained that post after Mr. Sprague's death in 1937.

Credit for the continued success of the concern had been accorded Mr. Hutchinson by those familiar with the company's progress. The late founder himself was one of the first to appreciate his business ability.

William P. Hutchinson

Few men in the gas industry have achieved the wide friendship and popularity among the utilities and the manufacturers such as that which "Bill" Hutchinson attained.

Mr. Hutchinson was born in Marion, Iowa, in 1883. Following his marriage to Grace A. Hallett of his native town, Mr. Hutchinson entered the employ of the Railway Express company, remaining for several years in the Middle West.

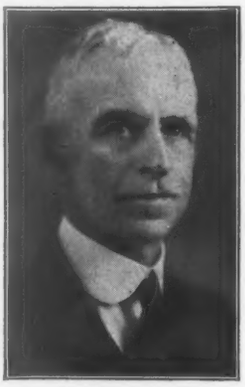
Active in civic and fraternal affairs, Mr. Hutchinson was a member of Bridgeport Lodge of Elks, Rotary club, Fairfield County Fish and Game association and Masonic orders, and the Bankers club of New York.

He was a director of the Black Rock Bank and Trust company and retired as vice president of the bank early this year.

Survivors are his widow and a daughter, Mrs. Marion Hall, wife of Wilford F. Hall, U.S.A.

LEVI H. DUNCAN

Levi H. Duncan, retired Sales Manager and long time employee of the Pittsburgh Equitable Meter Company, died April 20 at the home of his son, L. C. Duncan,



Levi H. Duncan

in Monroe, Louisiana, as the result of a cerebral hemorrhage. He was 78 years old. Mr. Duncan was first employed at the age of 18 as a machinist's apprentice by the Pittsburgh Supply Company. This firm later became the Equitable Meter Company, which in turn merged with the Pittsburgh Meter Company, to form the present Pittsburgh Equitable Meter Company. His entire business career, until retirement in 1931, was therefore devoted to the design, manufacture and sale of EMCO products. As a pioneer in gas measurement engineering, Mr. Duncan contributed much to the Gas Industry.

Crocker Appointed Manager of G-E Air Conditioning Department

Stuart M. Crocker has been named manager of the air conditioning department of the General Electric Company, effective at once, according to an announcement by Charles E. Wilson, executive vice president of the company. Simultaneously it was announced that the commercial refrigeration activities of the company, now located at Cleveland as part of the appliance and merchandise department, had been relinquished by the latter and assigned to the air conditioning department.

Koppers Announces Appointments

J. N. Forker, a vice president and director of Koppers Company, in charge of the Tar and Chemical division, has been appointed to the board of trustees of Eastern Gas and Fuel Associates, Boston.

E. S. Ruffin, Jr., assistant secretary and a member of the legal department of Koppers Company, also has been appointed to the board as assistant secretary.

Price Reduction

Condensation Engineering Corp., Chicago, Ill., announce a price reduction on their flue pipe for water heaters and circulating heaters. Acid resisting vitreous enamel is used in the manufacture of this flue pipe, which gives it a smooth glass-like finish.

Book Reviews

Air-Conditioning Engineers' Atlas

[*"Air-Conditioning Engineers' Atlas" by Clifford Strock and C. H. B. Hotchkiss. 76 pages, including 18 colored maps; size 9 x 12 in. Published by The Industrial Press, 148 Lafayette St., New York, N. Y. Price $2.00.*]

Heating and air conditioning engineers continually find it necessary to study weather data in connection with design and operating problems. The weather data that they need, however, are usually buried in such enormous masses of existing weather figures that it is frequently an impossible task to locate the desired information. The Air-Conditioning Engineers' Atlas is a new type of book presenting in condensed and usable form the climatic data needed for the solution of heating and cooling problems.

The Atlas consists of 18 sections, each containing a colored map of the United States, accompanied by pertinent data in tabular form; of these 18 sections nine deal with winter weather conditions and nine with summer weather conditions. The maps are zoned to show graphically, for all parts of the country, figures on the various phases of weather which are of concern to the heating and air conditioning engineer, while the tables contain supplementary data applying to the larger cities and their environs.

For the heating and air conditioning application engineer the Atlas furnishes extreme weather data required in calculating plant capacity. For the operating engineer it provides average climatic data for predicting operating quantities and obtaining good operating results. It is also useful in determining the potential markets for heating and air conditioning equipments and fuels, so far as climate is concerned.

The maps in the Atlas cover 18 full pages. These maps are printed in three colors and black, are unusually legible, and enable the determination of the desired figure for all parts of the United States. The subjects covered by the book are:

Winter Section:—Date Heating Season begins in a Normal Year; Date Season Ends in a Normal Year; Number of Days During a Normal Heating Season; Average Temperature During a Normal Heating Season; Lowest Temperatures of Record; Outside Design Temperatures and Wind Data for Winter Heating; Number of Hours an Automatic Heating Plant Operates; Frost Penetration in Ground, and Number of Degree-Days in a Normal Heating Season.

Summer Section:—Average Maximum Daily Temperature for July; Highest Temperatures of Record; Relative Humidity in July; Temperature and Availability of Well Water; Surface Water and City Water Temperatures During the Summer; Summer Degree Hours; Number of Hours Per Year of High Dry Bulb Temperatures; Wet Bulb and Simultaneous Dry Bulb and Dewpoint Temperatures; and Dry Bulb and Simultaneous Wet Bulb and Dewpoint Temperatures.

HUGHES PRINTING CO.
EAST STROUDSBURG, PA.